US009104172B2

(12) United States Patent
Takagi

(10) **Patent No.: US 9,104,172 B2**
(45) **Date of Patent: Aug. 11, 2015**

(54) **DETECTING A DEVELOPING CARTRIDGE**

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(72) Inventor: **Takeyuki Takagi**, Nagoya (JP)

(73) Assignee: **Brother Kogyo Kabushiki Kaisha**, Nagoya-shi, Aichi-ken (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/189,305**

(22) Filed: **Feb. 25, 2014**

(65) **Prior Publication Data**

US 2014/0241756 A1 Aug. 28, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/053,074, filed on Mar. 21, 2011, now Pat. No. 8,676,064.

(30) **Foreign Application Priority Data**

Mar. 24, 2010 (JP) 2010-068573

(51) **Int. Cl.**
G03G 15/00 (2006.01)
G03G 21/16 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G03G 21/1647*** (2013.01); ***G03G 15/0896*** (2013.01); ***G03G 21/1896*** (2013.01); *G03G 2221/1892* (2013.01)

(58) **Field of Classification Search**
USPC 399/12, 13, 111, 119
IPC ... G03G 15/0896,21/1647, 21/1896, 2221/1892
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,953,330 B2 5/2011 Ishikawa
8,417,130 B2 4/2013 Hashimoto
(Continued)

FOREIGN PATENT DOCUMENTS

EP 1696283 A1 8/2006
EP 1696284 A2 8/2006
(Continued)

OTHER PUBLICATIONS

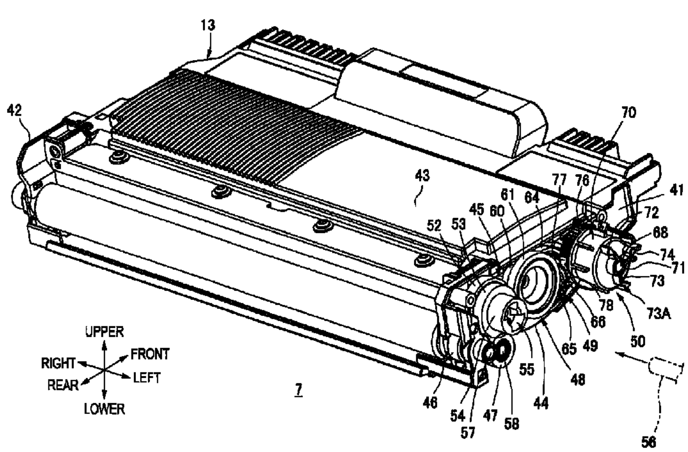
European Patent Office, European Search Report for European Patent Application No. 11002318.1 (counterpart to co-pending U.S. Appl. No. 13/053,074), dated Jun. 30, 2011.
(Continued)

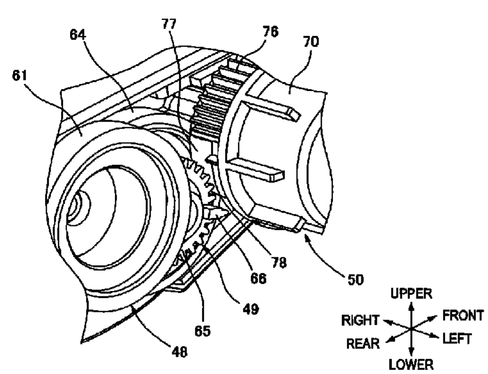
Primary Examiner — Robert Beatty
(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

(57) **ABSTRACT**

A developing cartridge is provided. The developing cartridge includes a housing which accommodates developer therein, a receiving member which receives a driving force output member provided in an image forming apparatus, a developing roller which rotates by the driving force received by the receiving member, and a detectable rotary member including a detectable portion, which is a detection target to be detected by a detection member provided in the image forming apparatus, and a contact portion which is provided away from the detectable portion. The detectable rotary member rotates from a retreat position to an initial position where the detectable rotary member is rotated by the driving force received by the receiving member, by the contact portion contacting an interference member fixed in the image forming apparatus in a process of mounting the developing cartridge into the image forming apparatus.

42 Claims, 37 Drawing Sheets





(51) **Int. Cl.**
G03G 15/08 (2006.01)
G03G 21/18 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0031359	A1	2/2005	Ishii
2006/0193643	A1	8/2006	Takagi et al.
2006/0193645	A1	8/2006	Kishi
2006/0193646	A1	8/2006	Suzuki et al.
2008/0205911	A1	8/2008	Ishikawa et al.
2008/0205931	A1	8/2008	Ishikawa
2008/0223173	A1	9/2008	Ishikawa
2009/0000423	A1	1/2009	Ishikawa et al.
2009/0269086	A1	10/2009	Mikuni
2011/0236062	A1	9/2011	Takagi
2011/0236065	A1	9/2011	Takagi

FOREIGN PATENT DOCUMENTS

EP	1965274	A2	9/2008
JP	H05-204195	A	8/1993
JP	2005-055544	A	3/2005
JP	2006-163304	A	6/2006
JP	2006-243072	A	9/2006
JP	2006-267994	A	10/2006
JP	2008-216394	A	9/2008
JP	2009-244562	A	10/2009
JP	2009-265401	A	11/2009

OTHER PUBLICATIONS

European Patent Office, European Search Report for European Patent Application No. 11002316.5 (counterpart to co-pending U.S. Appl. No. 13/053,074), dated Jun. 30, 2011.

European Patent Office, European Search Report for European Patent Application No. 11002317.3 (counterpart to co-pending U.S. Appl. No. 13/053,074), dated Jun. 30, 2011.

Japan Patent Office, International Search Report for International Patent Application No. PCT/JP2011/057128 (counterpart to co-pending U.S. Appl. No. 13/053,074), mailed Apr. 26, 2011.

The State Intellectual Property Office of the People's Republic of China, Notification of First Office Action for Chinese Patent Application No. 201110077194.1 (counterpart to co-pending U.S. Appl. No. 13/053,074), issued Aug. 9, 2012.

The State Intellectual Property Office of the People's Republic of China, Notification of First Office Action for Chinese Patent Application No. 201110077268.1 (counterpart to co-pending U.S. Appl. No. 13/053,074), issued Aug. 13, 2012.

The State Intellectual Property Office of the People's Republic of China, Notification of First Office Action for Chinese Patent Application No. 201110075937.1 (counterpart to co-pending U.S. Appl. No. 13/053,074), issued Aug. 2, 2012.

Japan Patent Office, International Search Report for International Patent Application No. PCT/JP2011/057127 (counterpart to co-pending U.S. Appl. No. 13/053,074), mailed Apr. 26, 2011.

Japan Patent Office, International Search Report for International Patent Application No. PCT/JP2011/057129 (counterpart to co-pending U.S. Appl. No. 13/053,074), mailed Apr. 26, 2011.

Japan Patent Office, Notification of Reasons for Refusal for Japanese Patent Application No. 2010-068573 (counterpart to co-pending U.S. Appl. No. 13/053,074), dispatched Nov. 19, 2013.

Japan Patent Office, Notification of Reasons for Refusal for Japanese Patent Application No. 2010-068572 (counterpart to co-pending U.S. Appl. No. 13/053,074), dispatched Nov. 19, 2013.

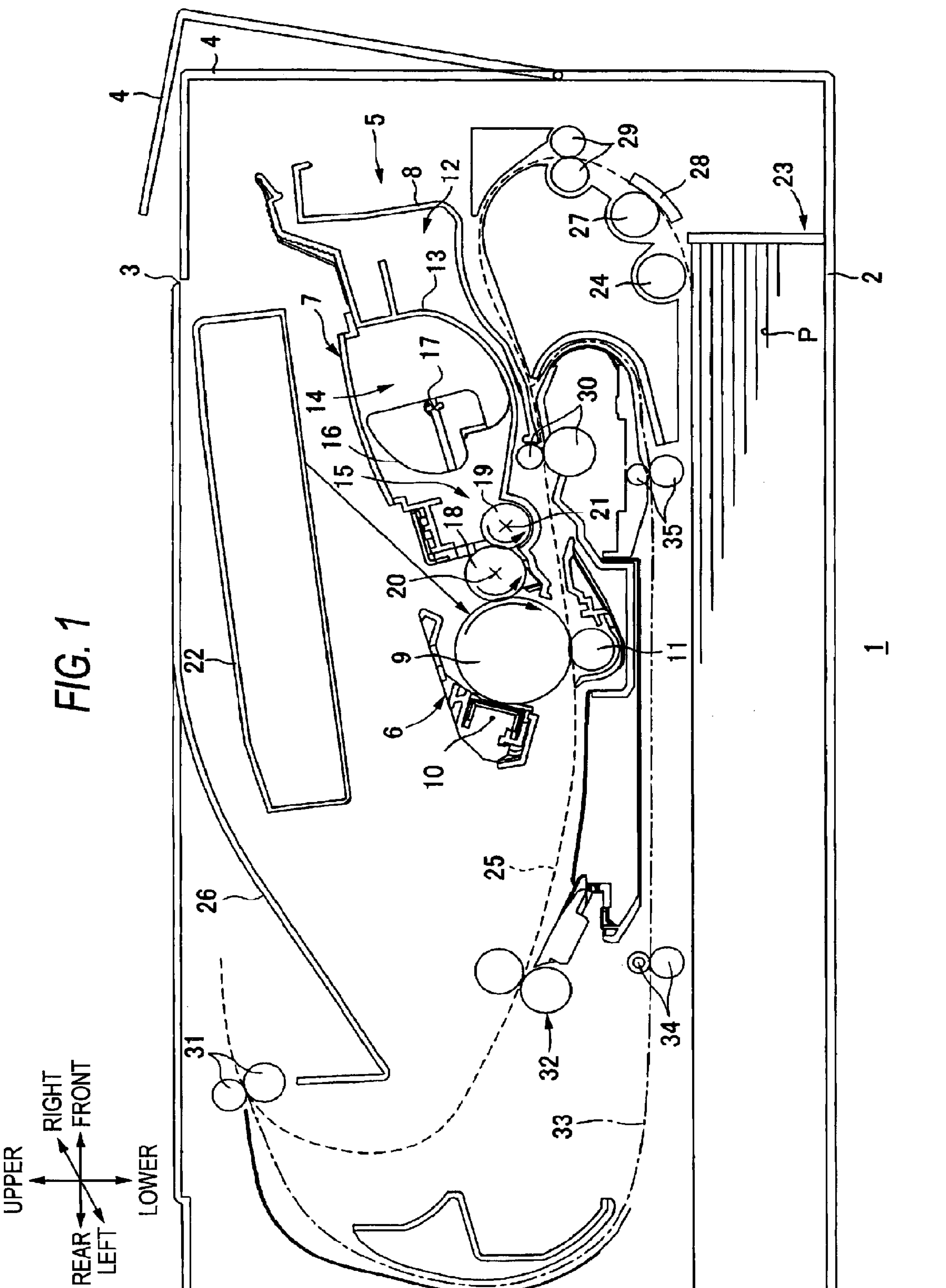

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FIG. 1

FIG. 2A

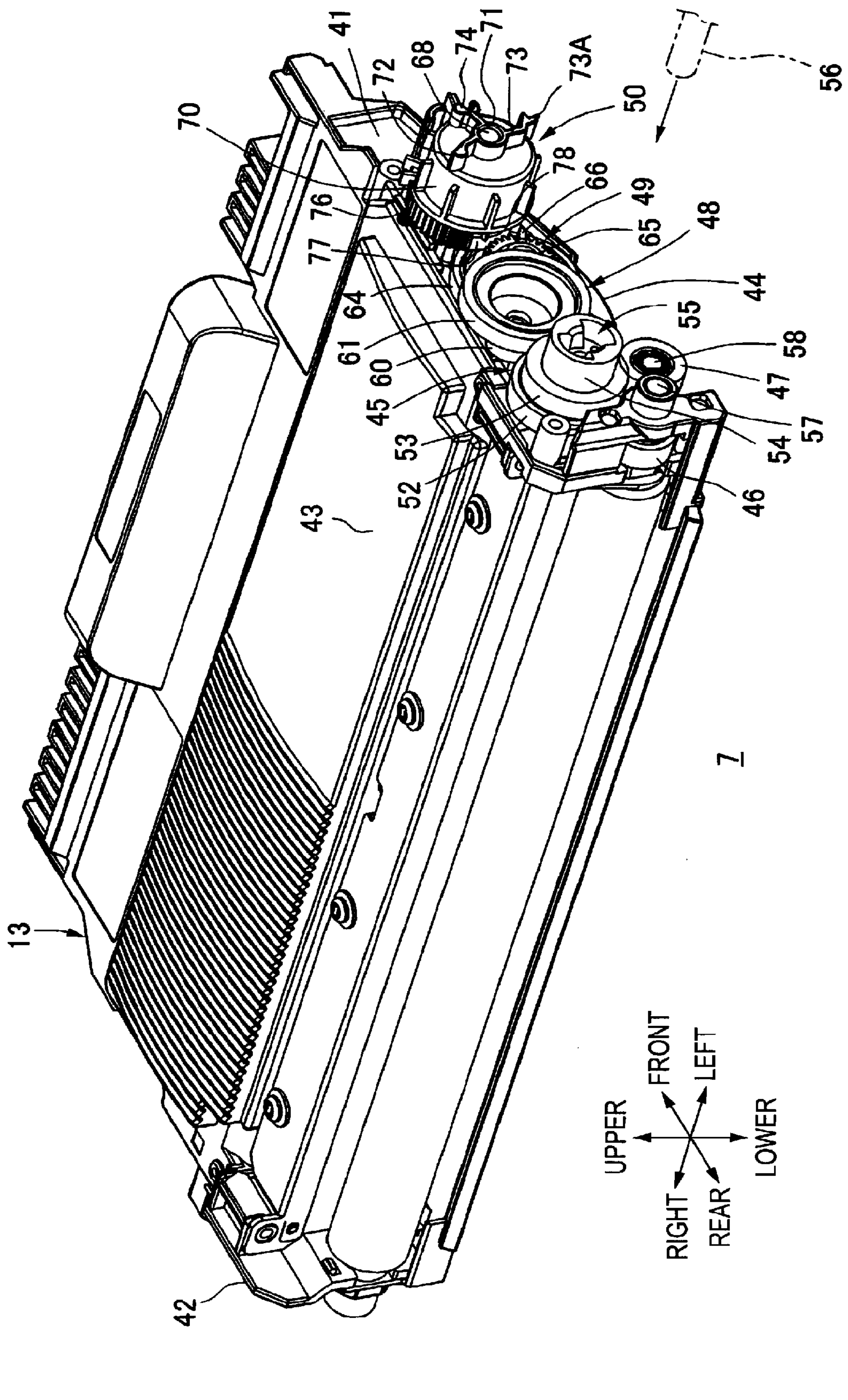

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FIG. 2B

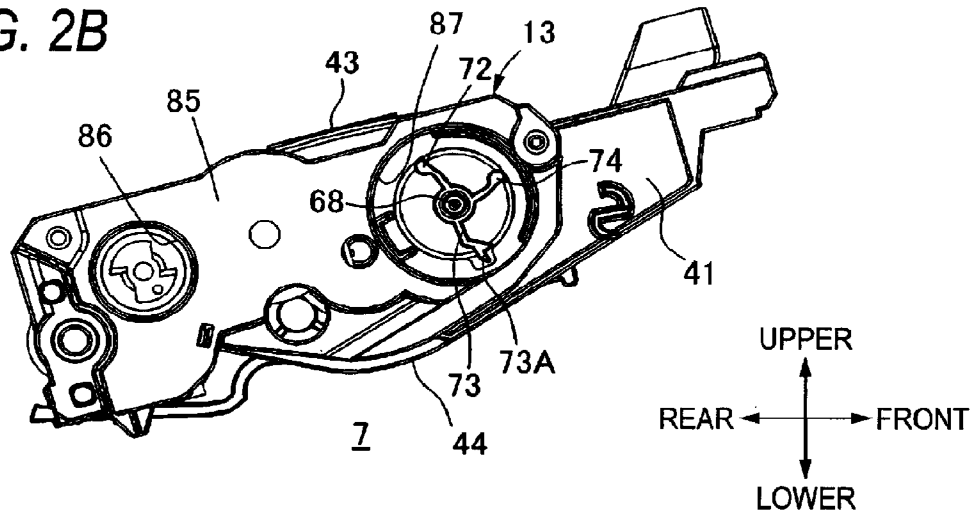
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FIG. 2C

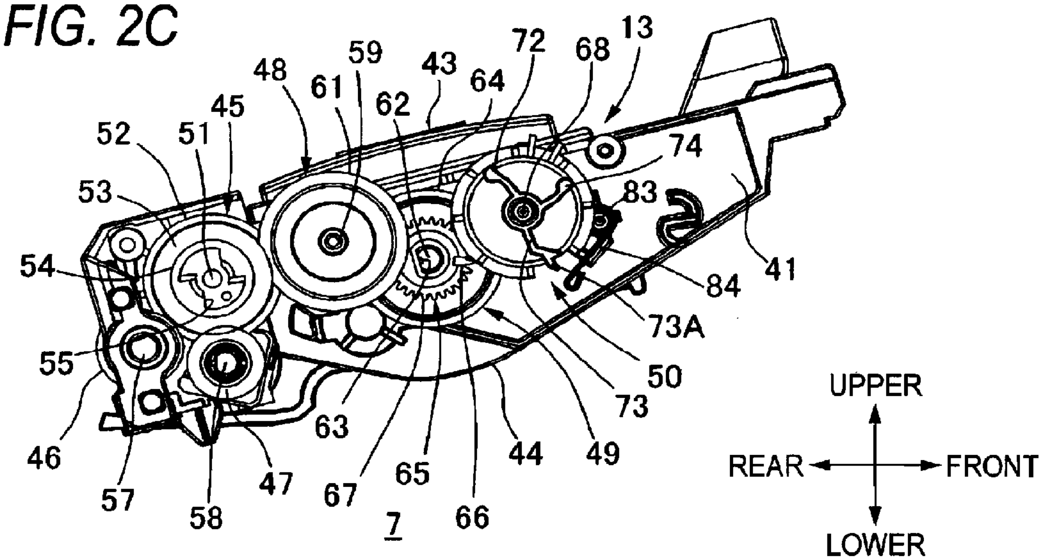
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FIG. 2D

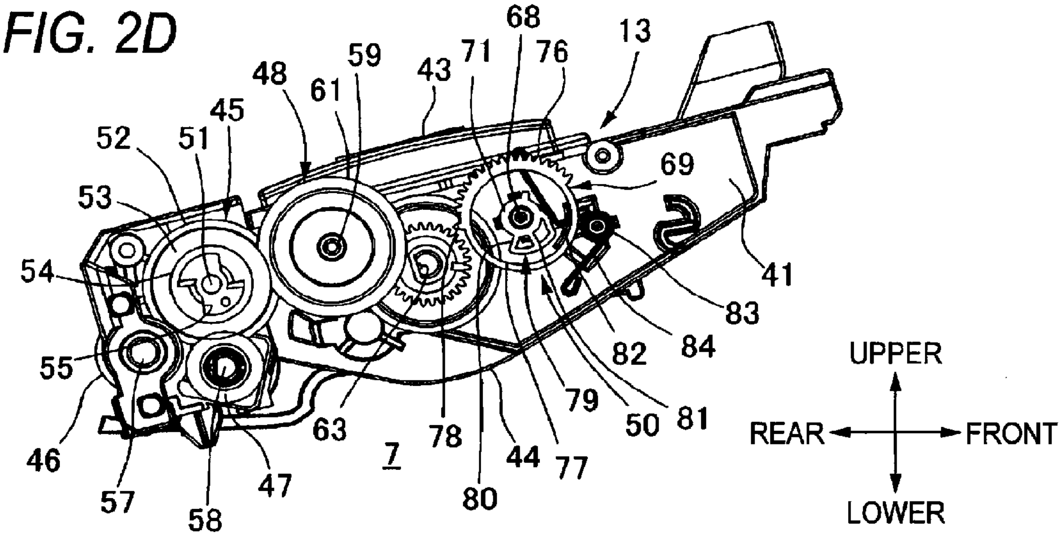
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FIG. 2E

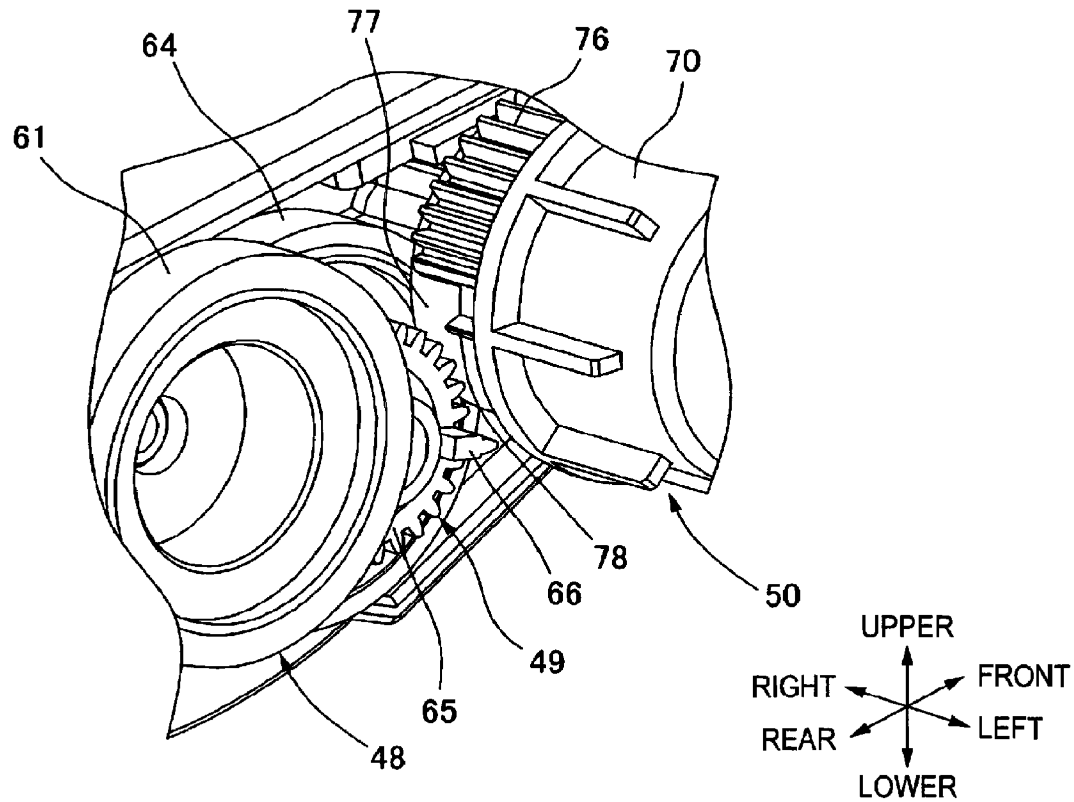
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FIG. 3A

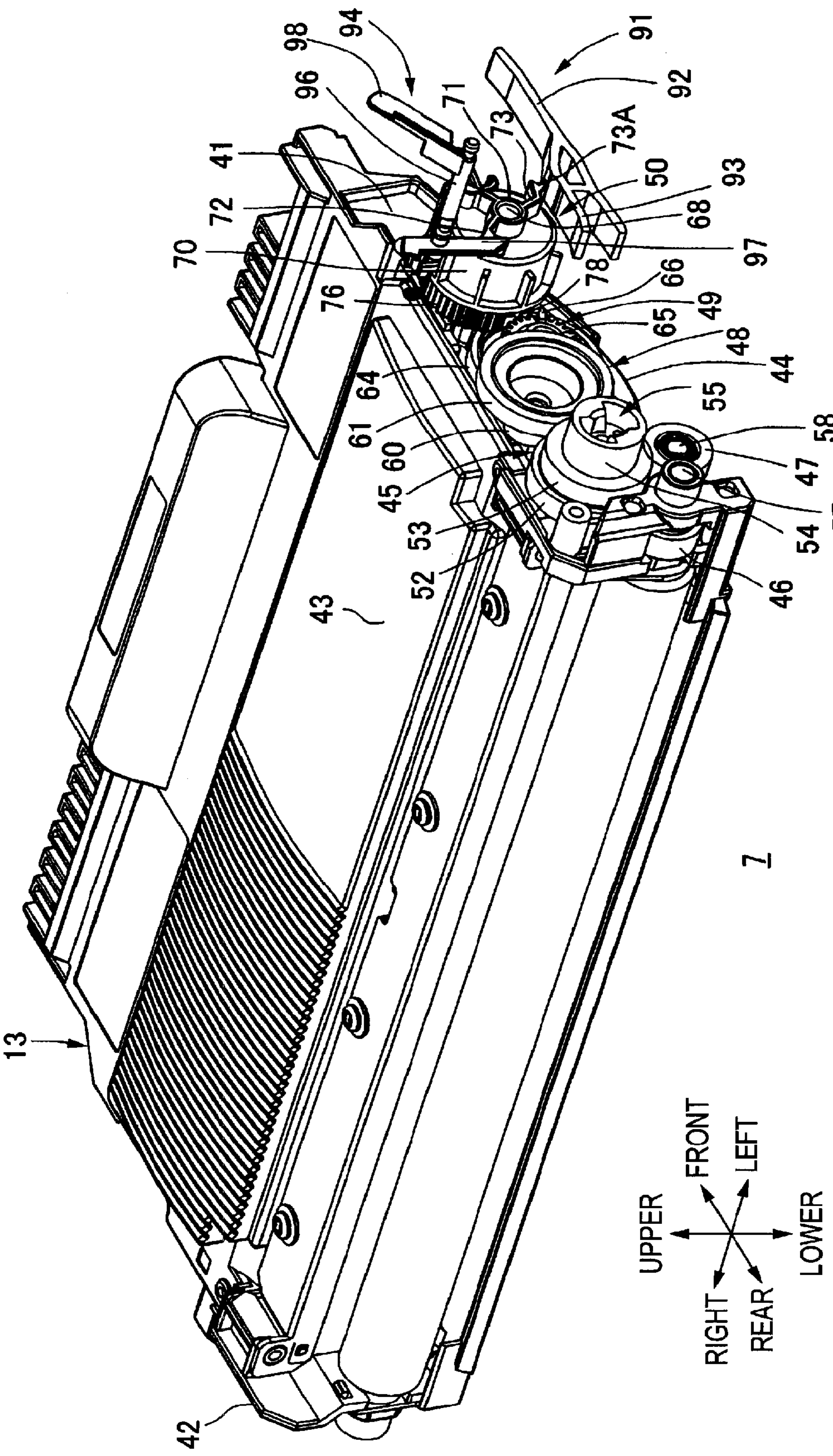
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FIG. 3B

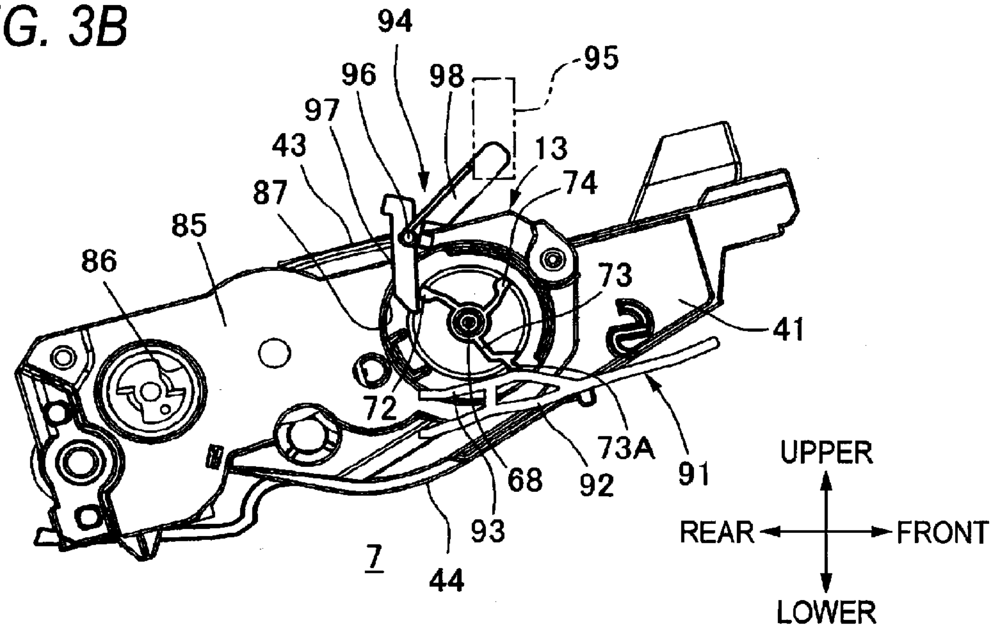
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FIG. 3C

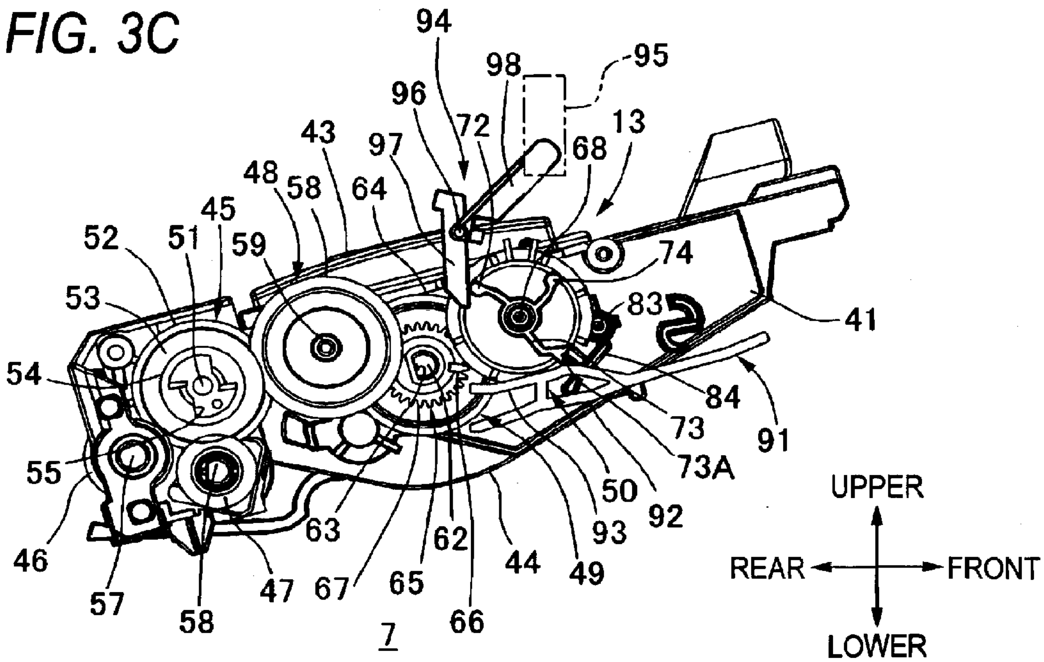
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FIG. 3D

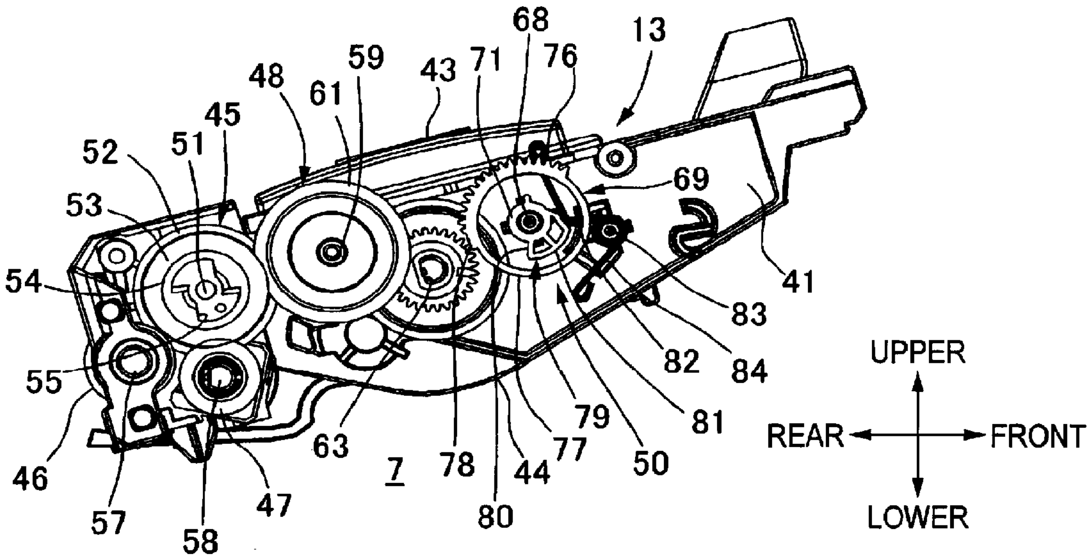

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FIG. 4A

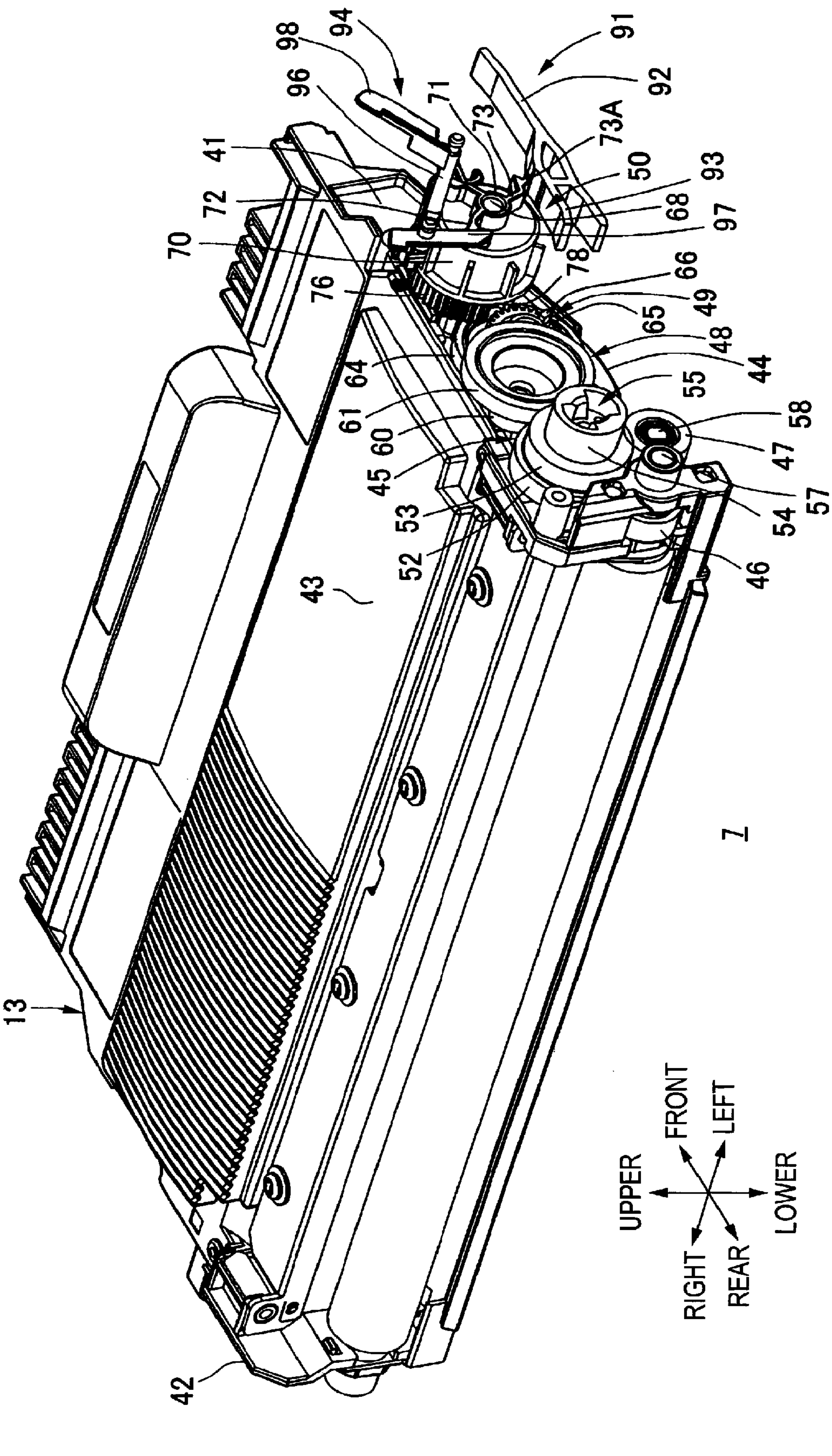
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FIG. 4B

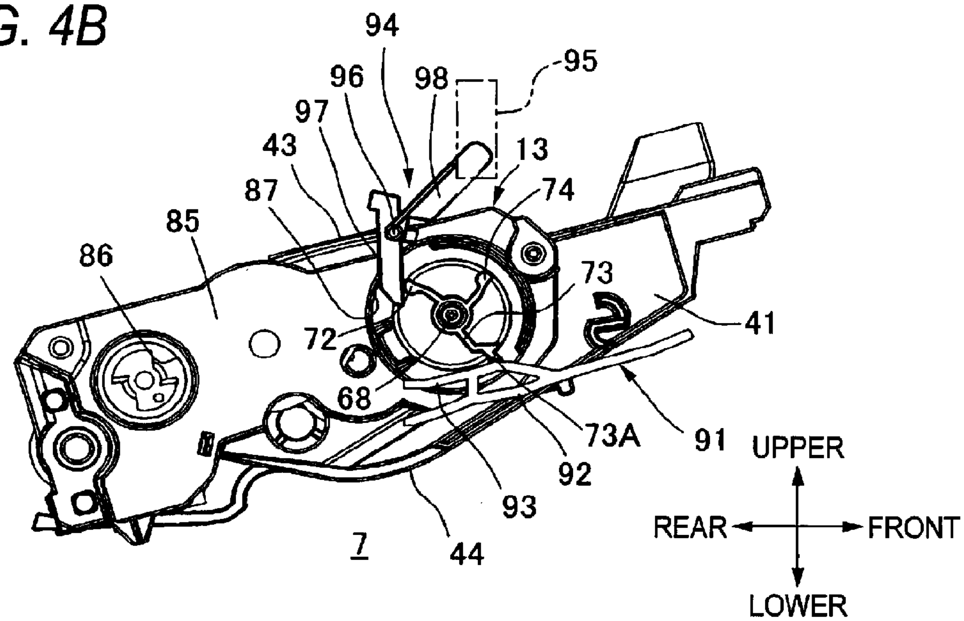
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FIG. 4C

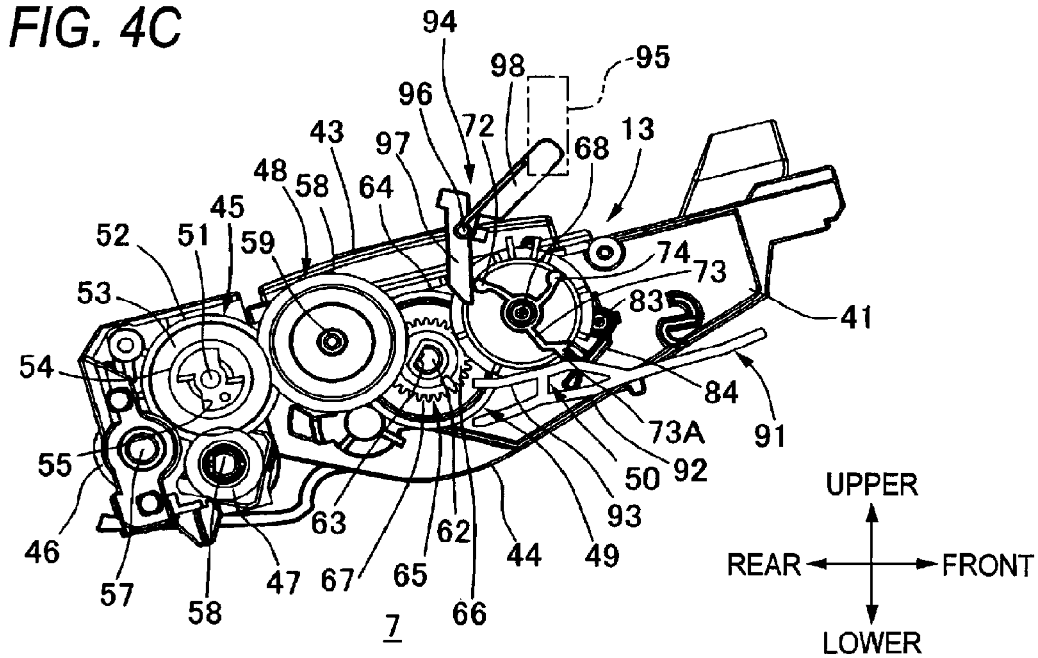
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FIG. 4D

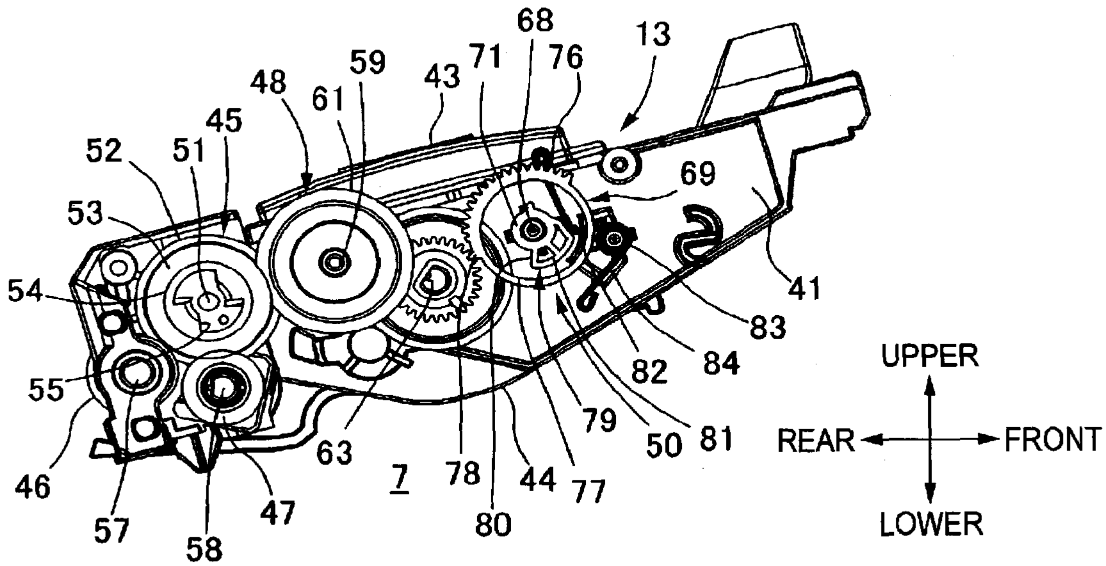
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FIG. 5A

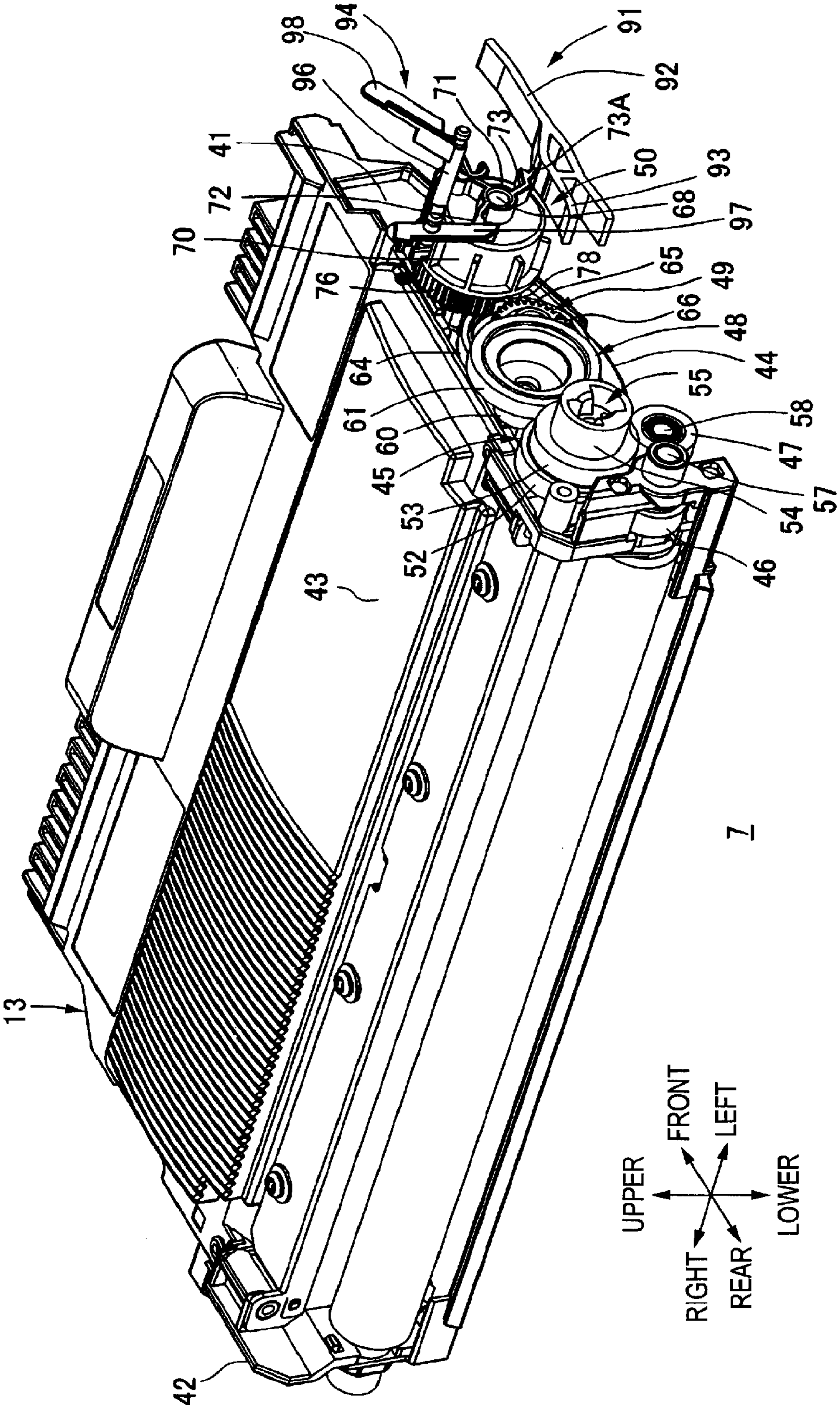
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FIG. 5B

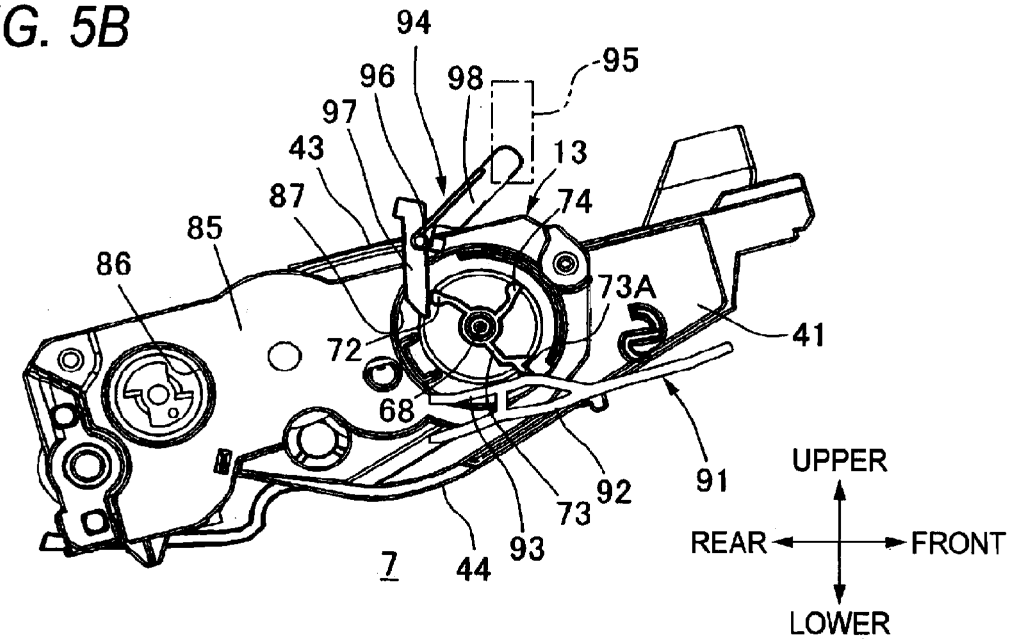
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FIG. 5C

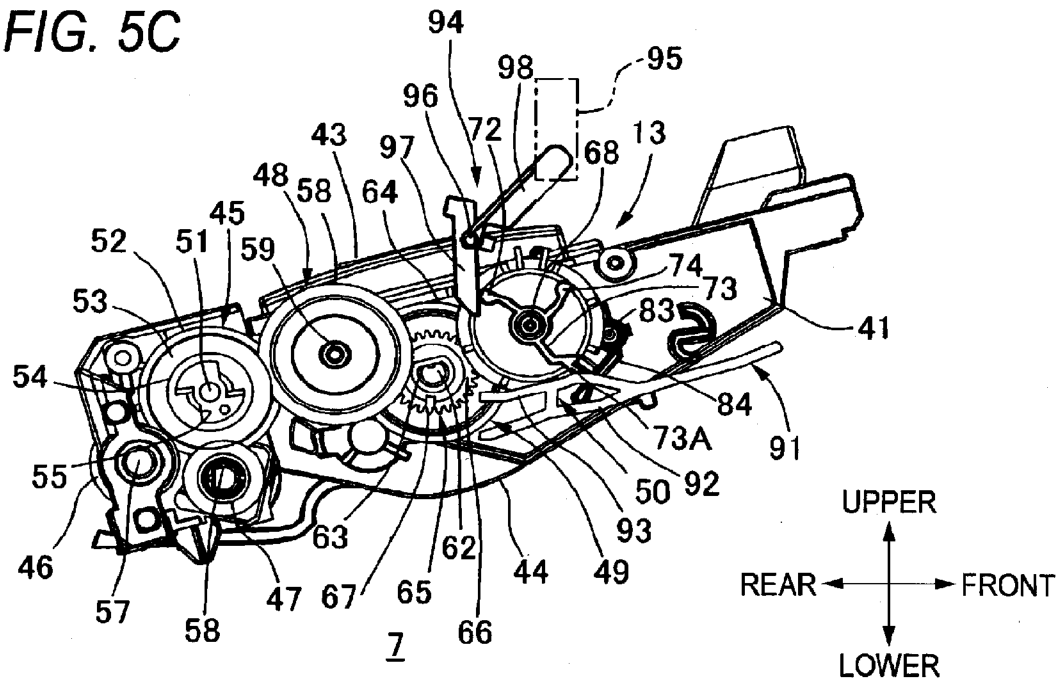
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FIG. 5D

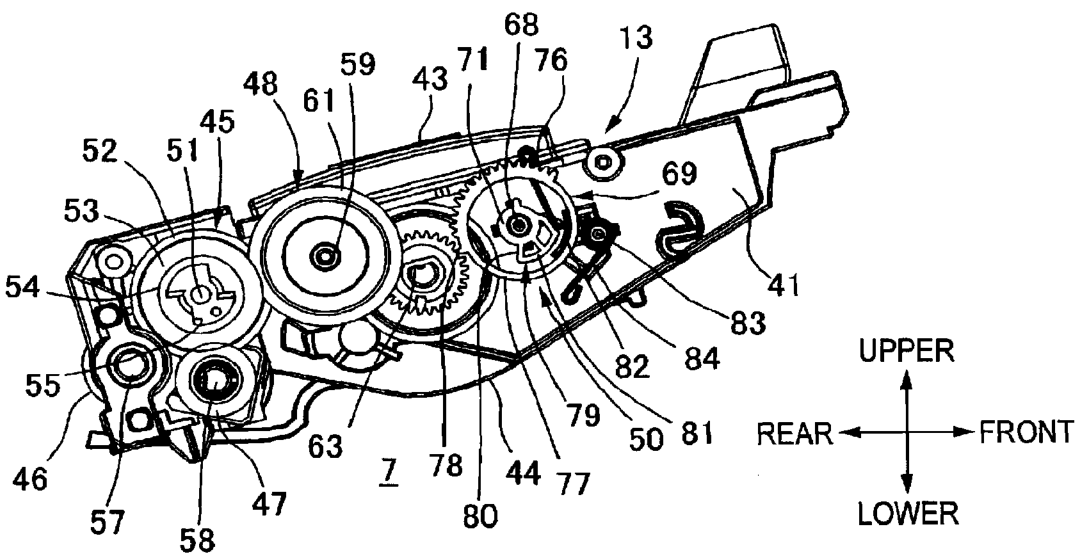
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FIG. 6A

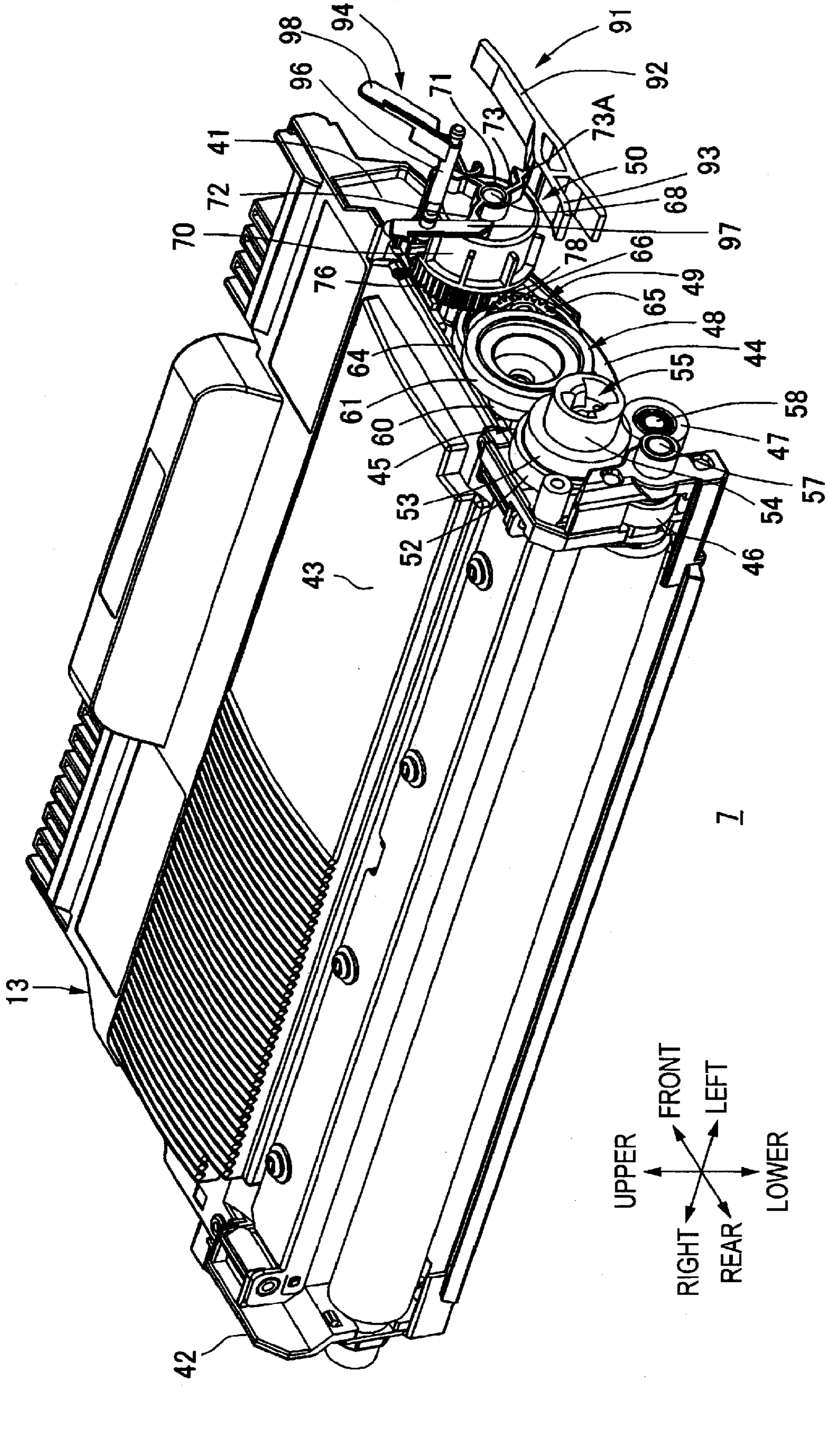
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FIG. 6B

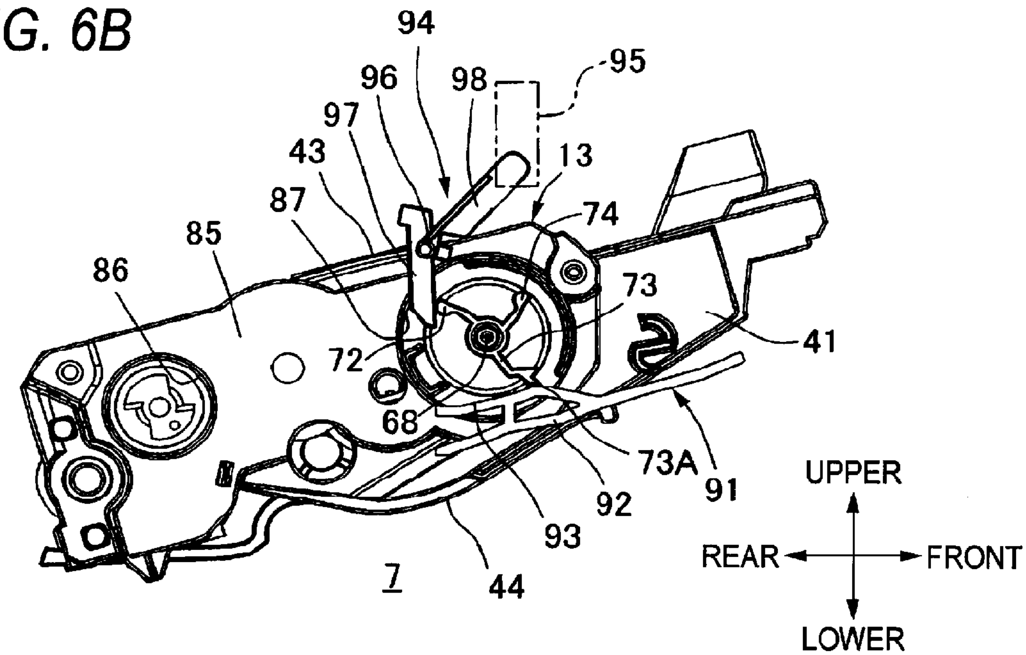
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FIG. 6C

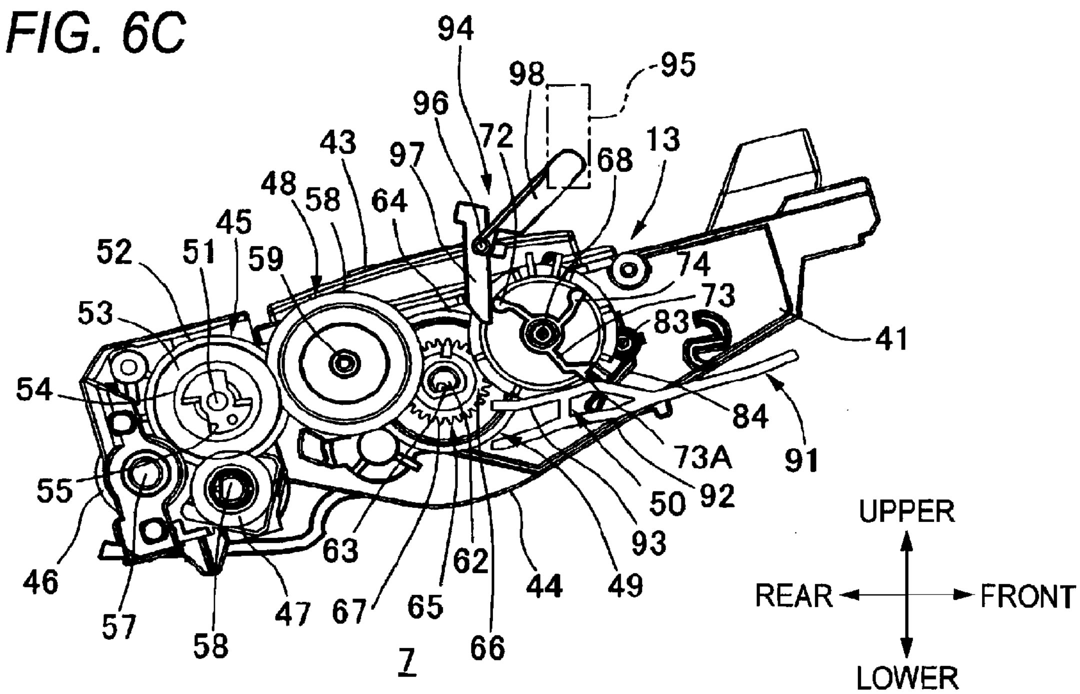
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FIG. 6D

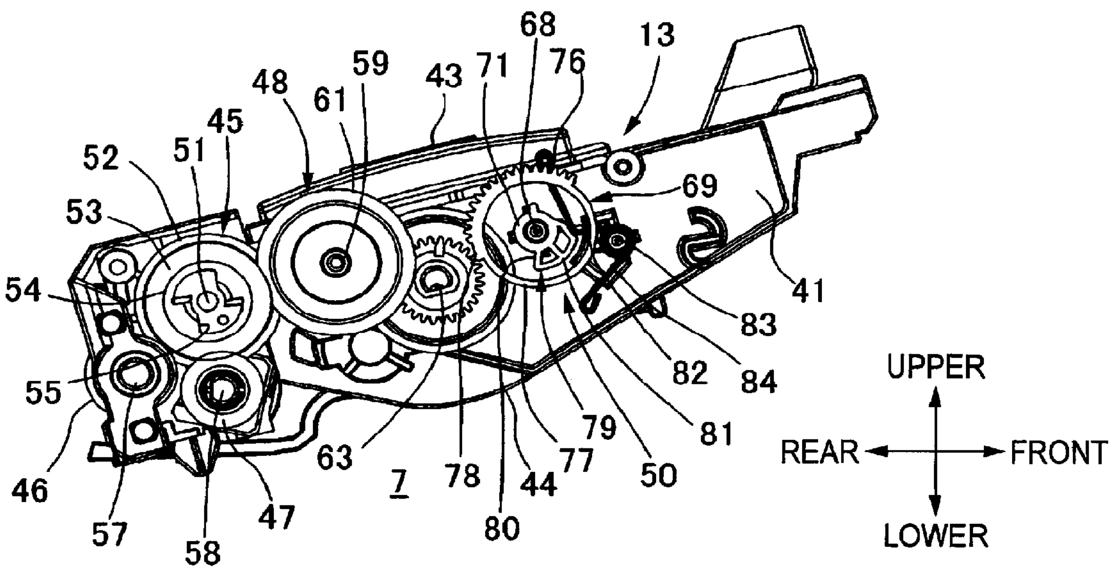

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FIG. 7A

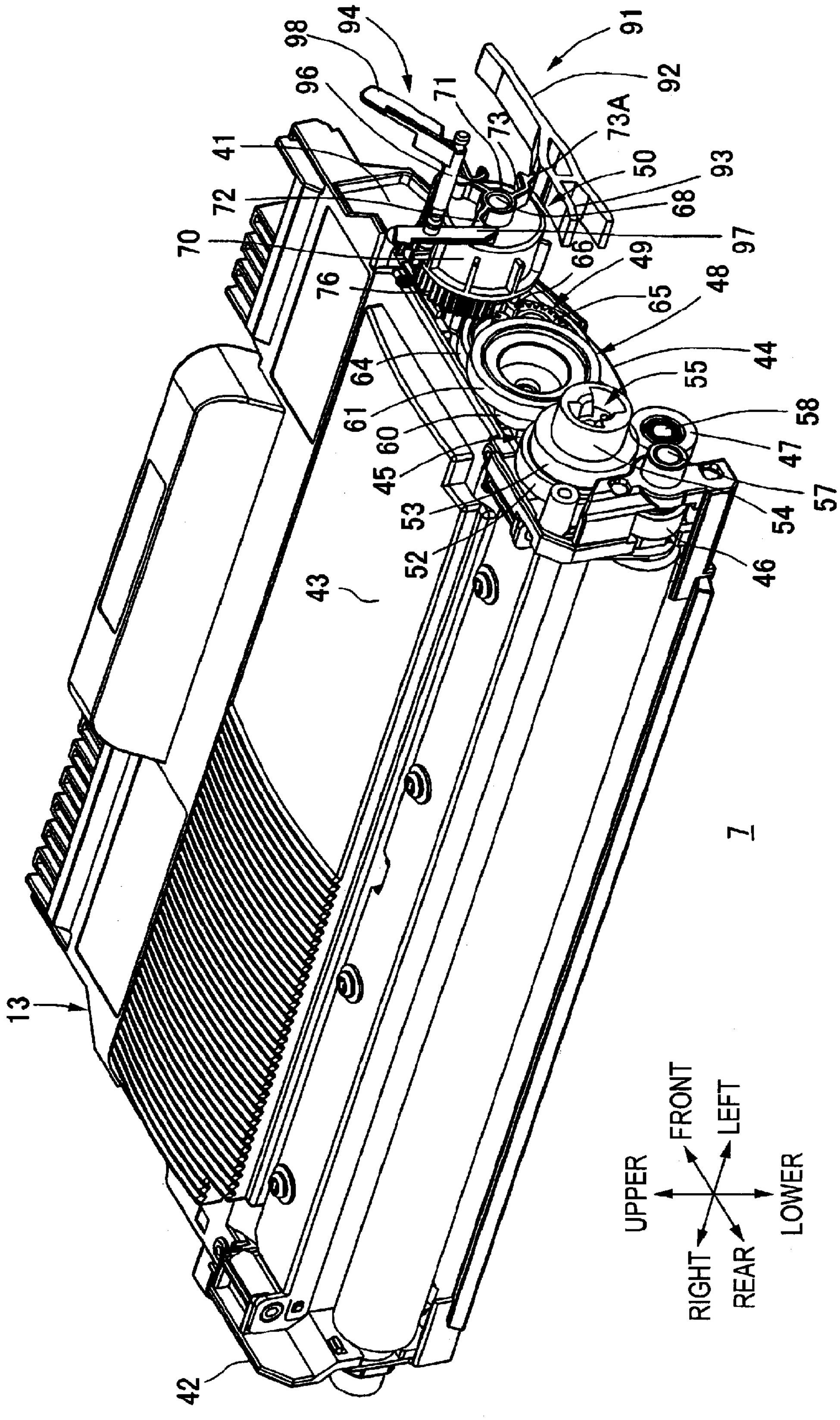

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FIG. 7B

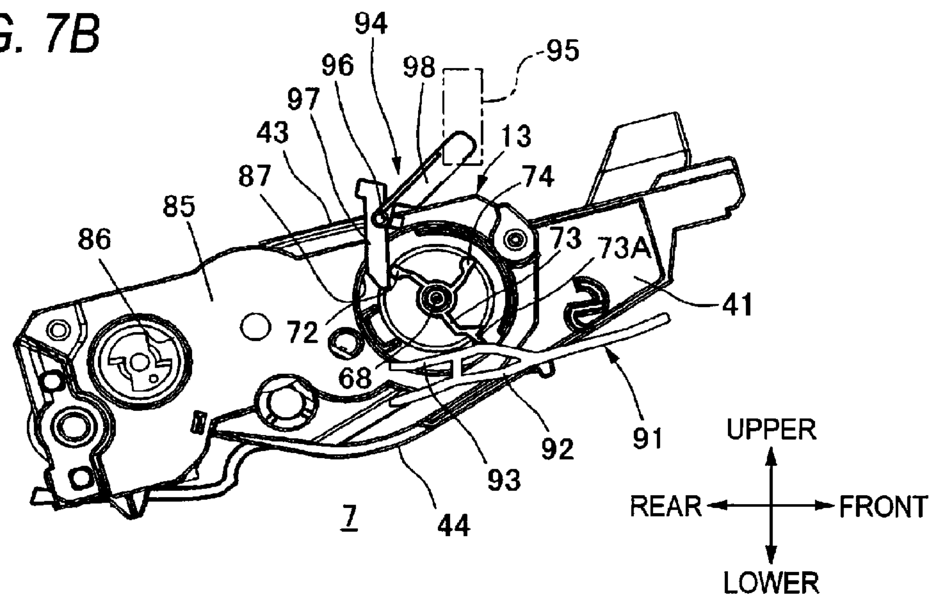
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FIG. 7C

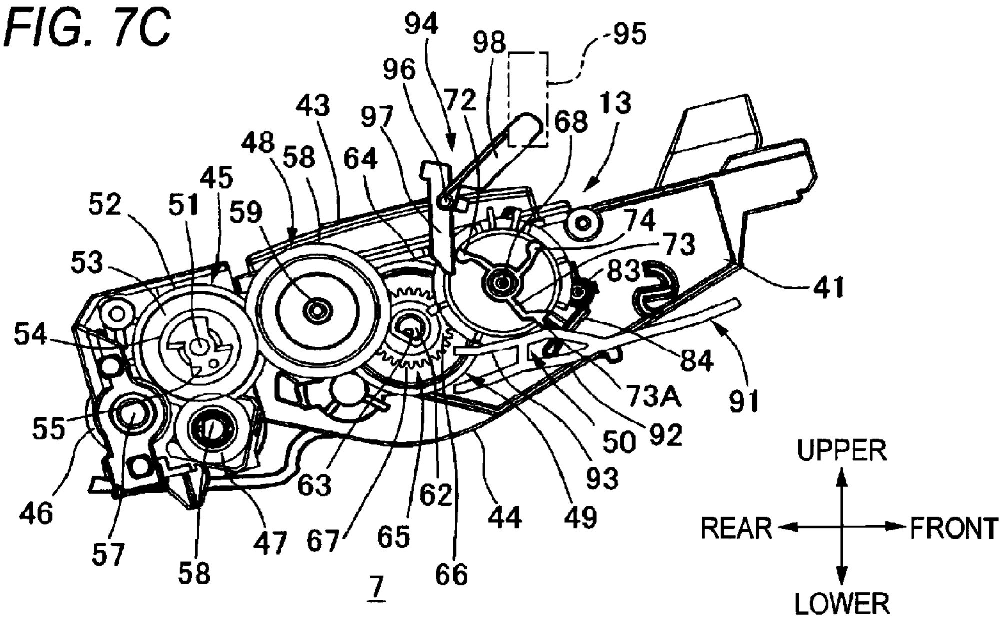
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FIG. 7D

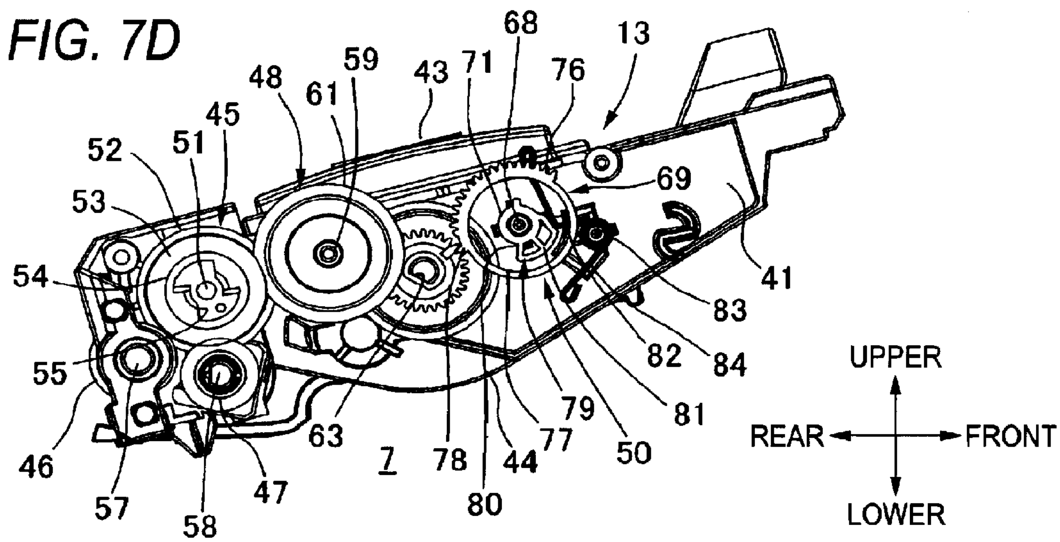

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FIG. 7E

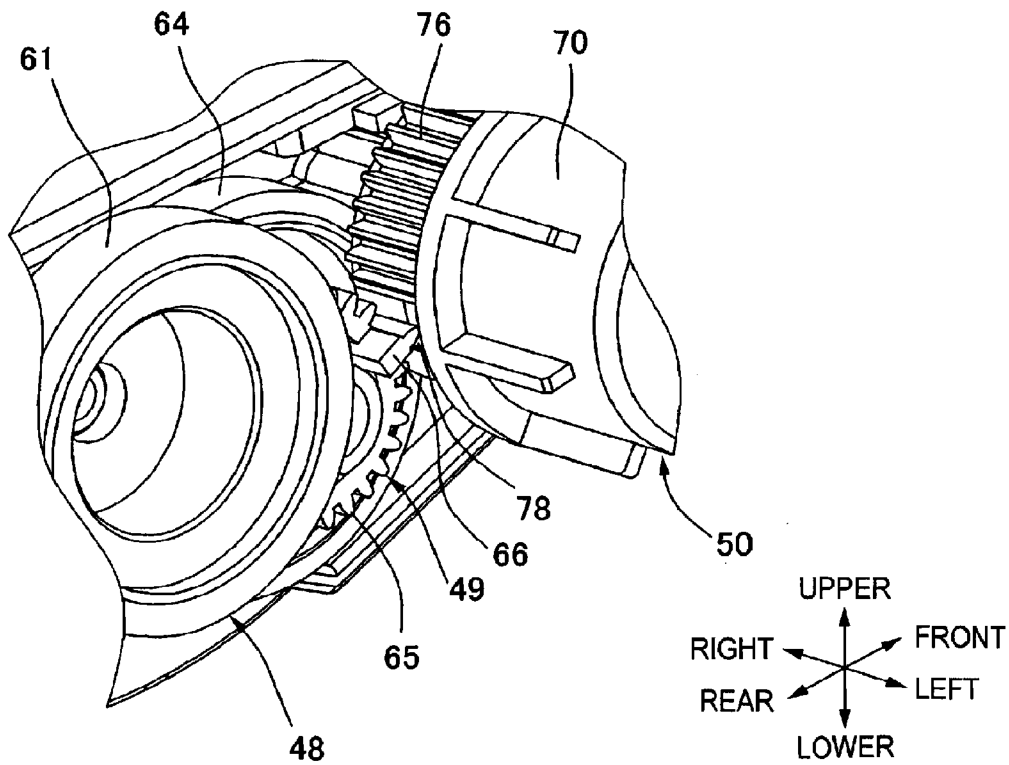

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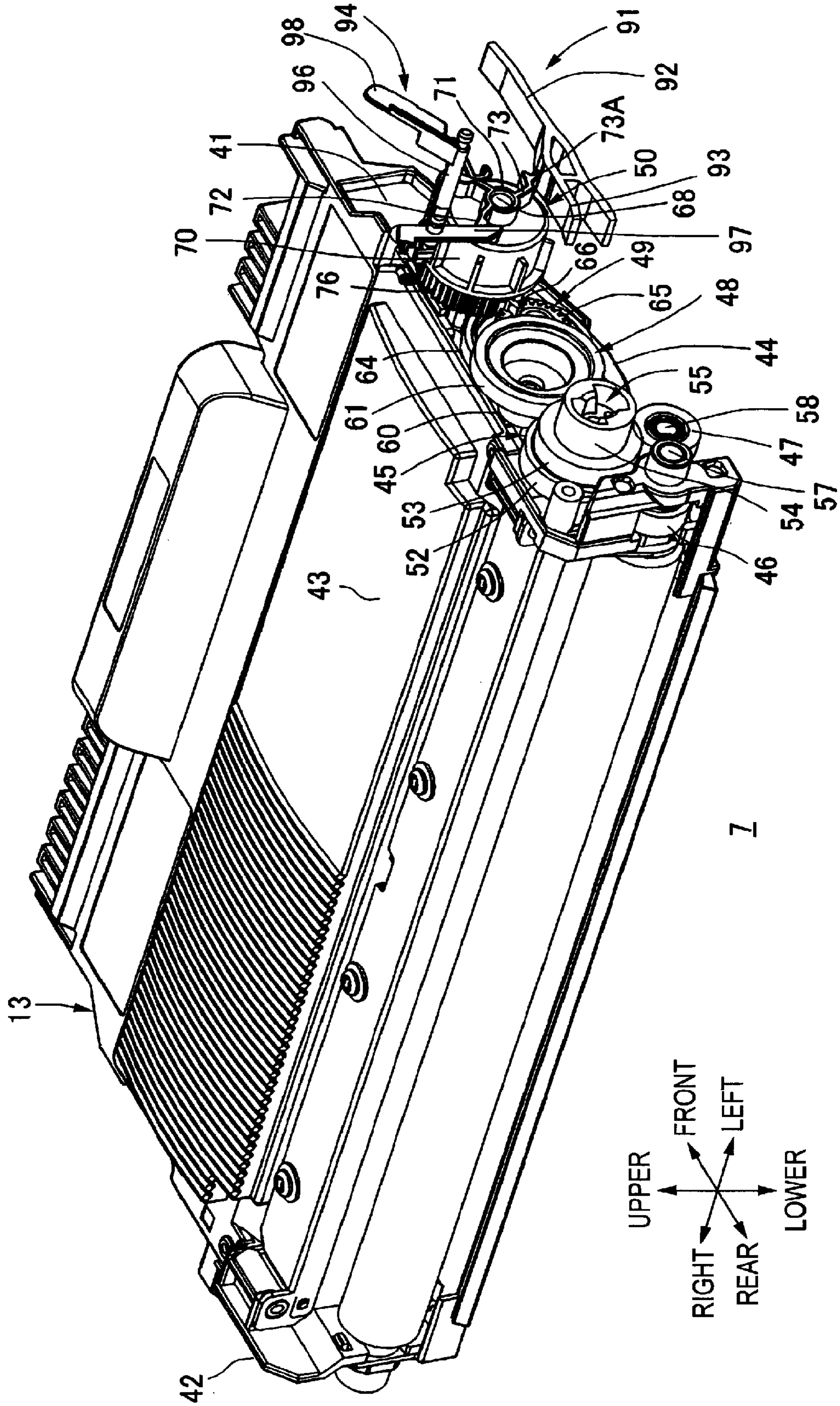
FIG. 8A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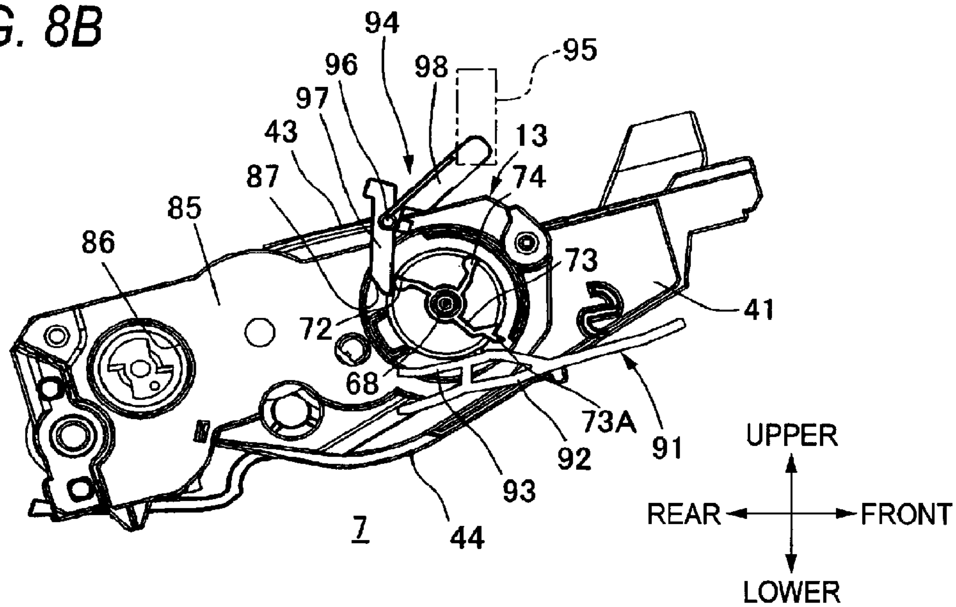
13
7
42
UPPER
FRONT
LEFT
LOWER
RIGHT
REAR

FIG. 8B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73
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72
41
68
73A
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93
44
7
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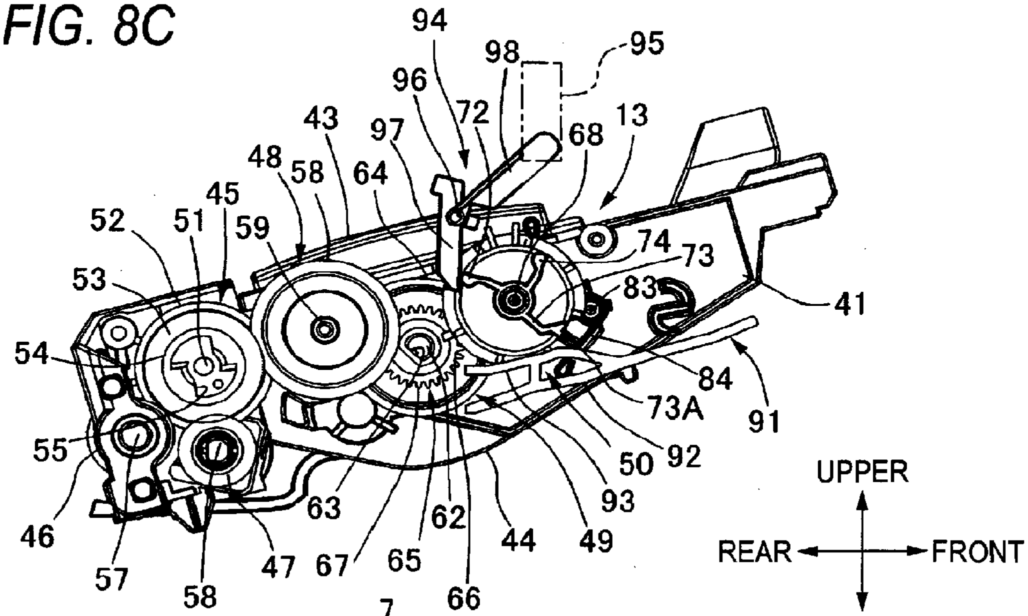
REAR
FRONT
LOWER

FIG. 8C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73A
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REAR
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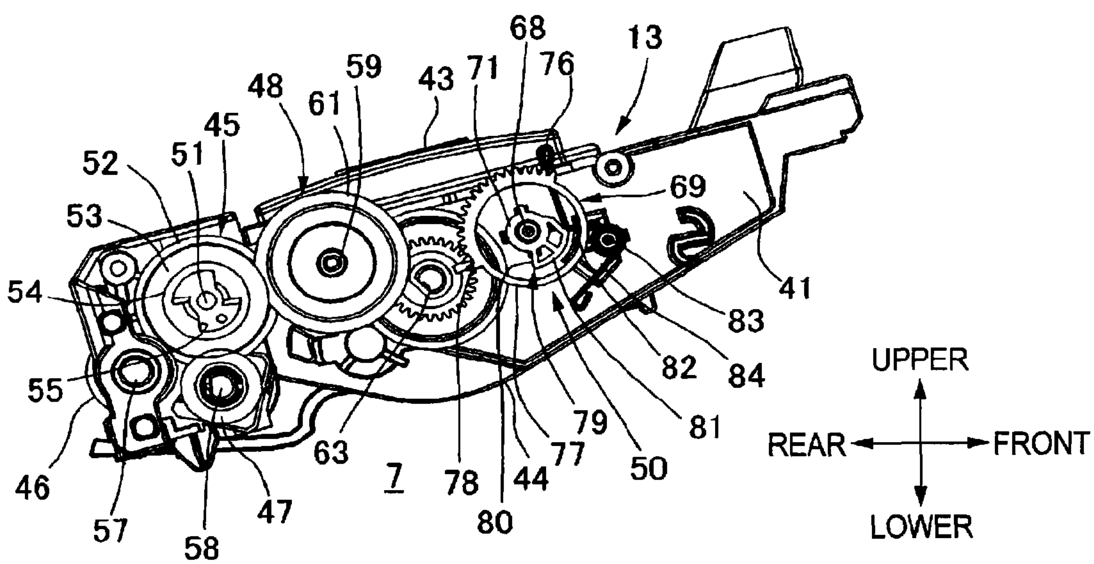
FIG. 8D



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UPPER
REAR
FRONT
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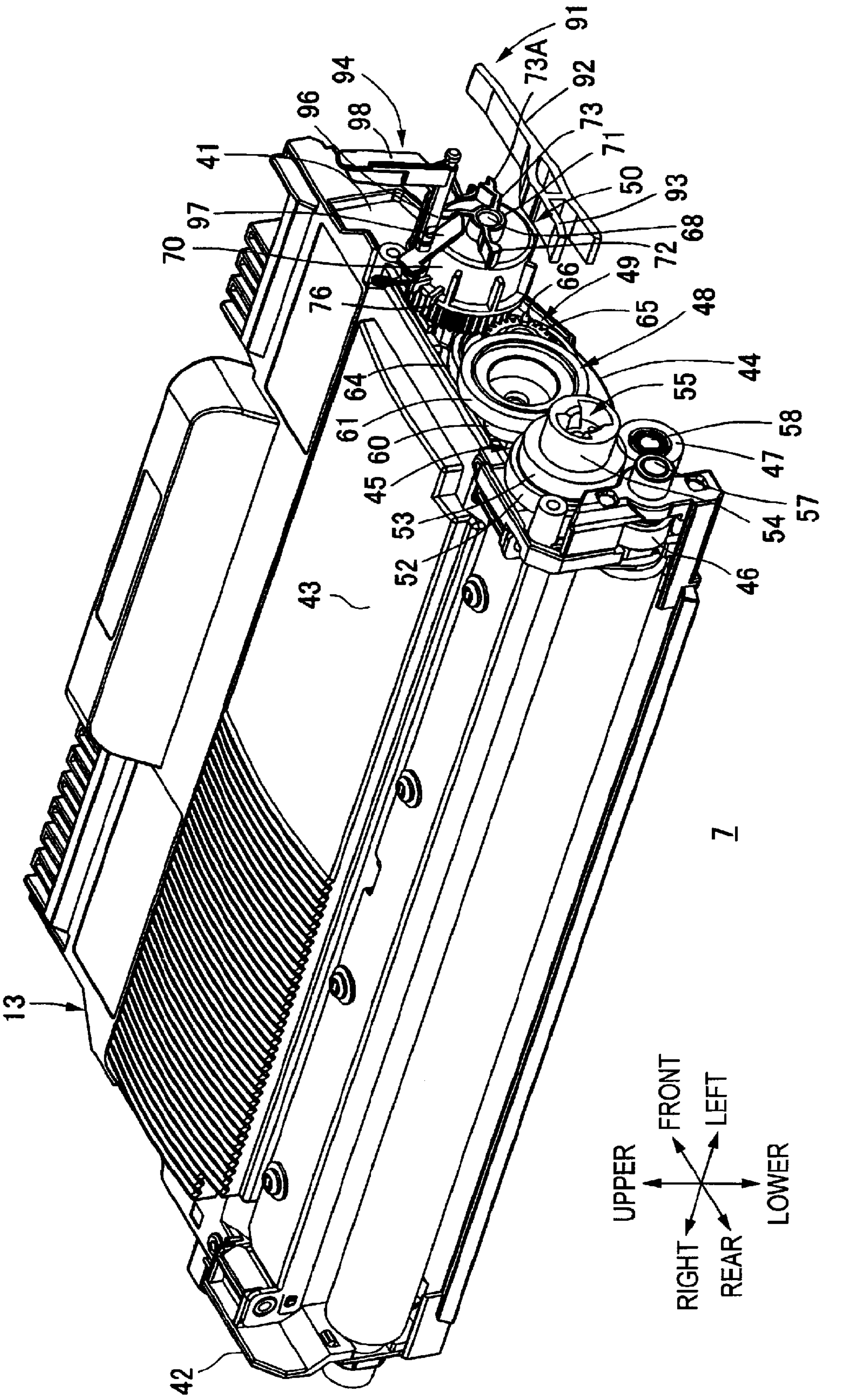
FIG. 9A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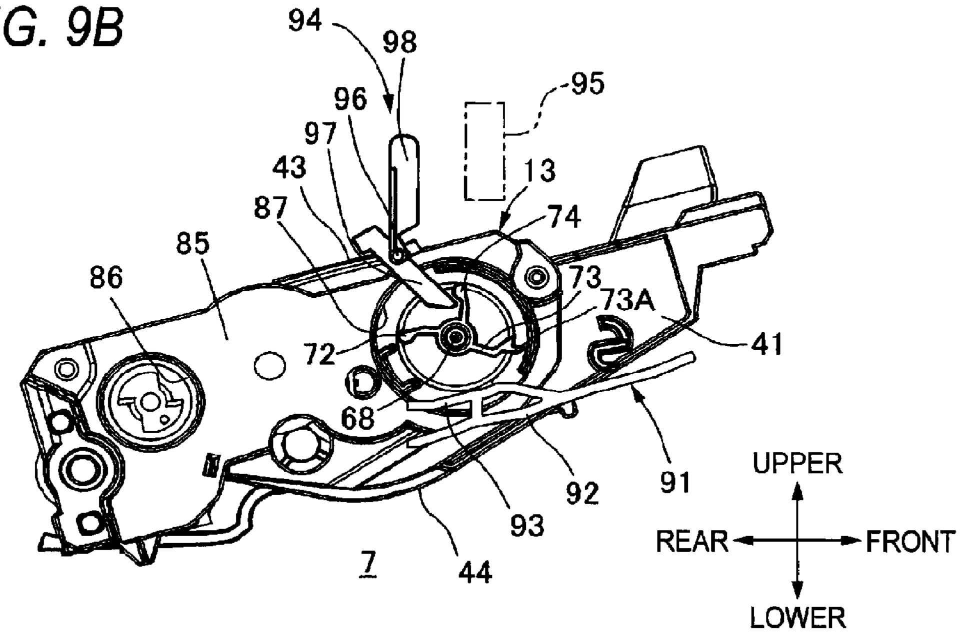
FRONT
LEFT
UPPER
LOWER
RIGHT
REAR

FIG. 9B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FRONT
LOWER
7
44

FIG. 9C

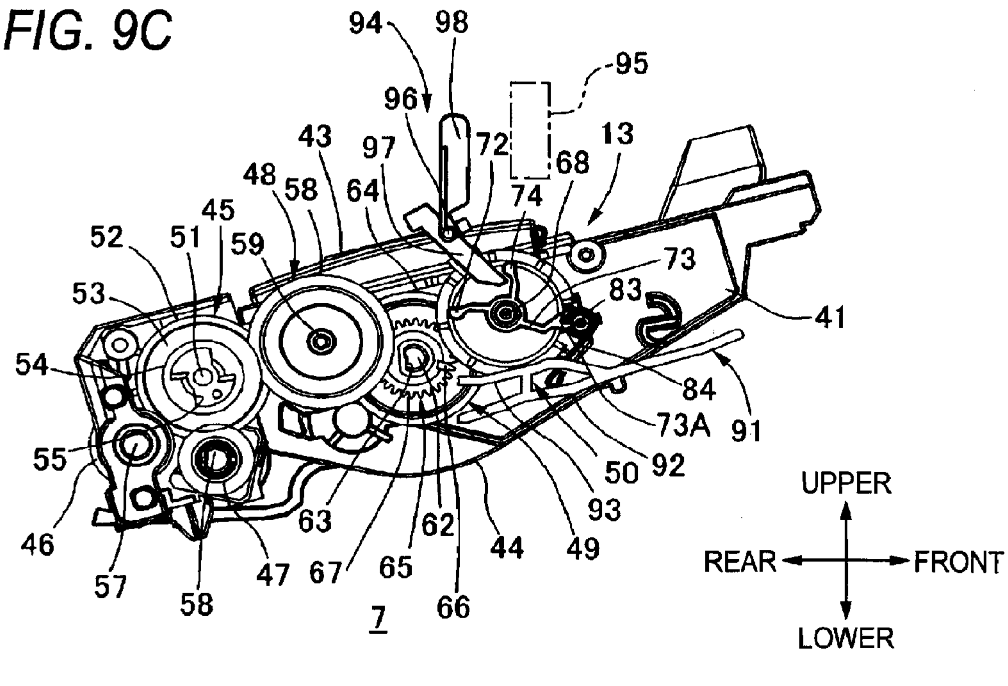
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FIG. 9D

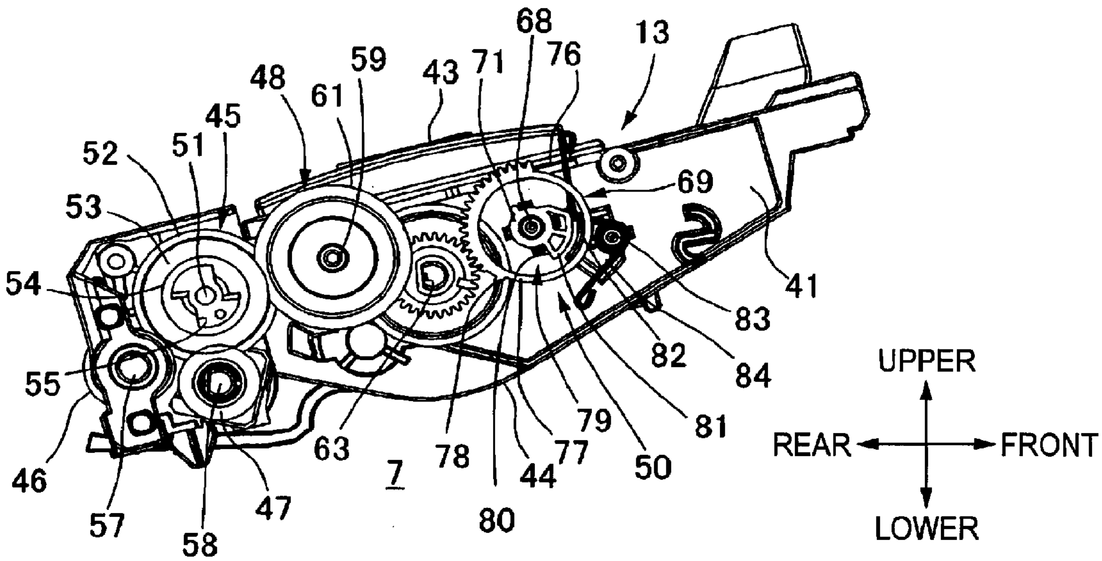
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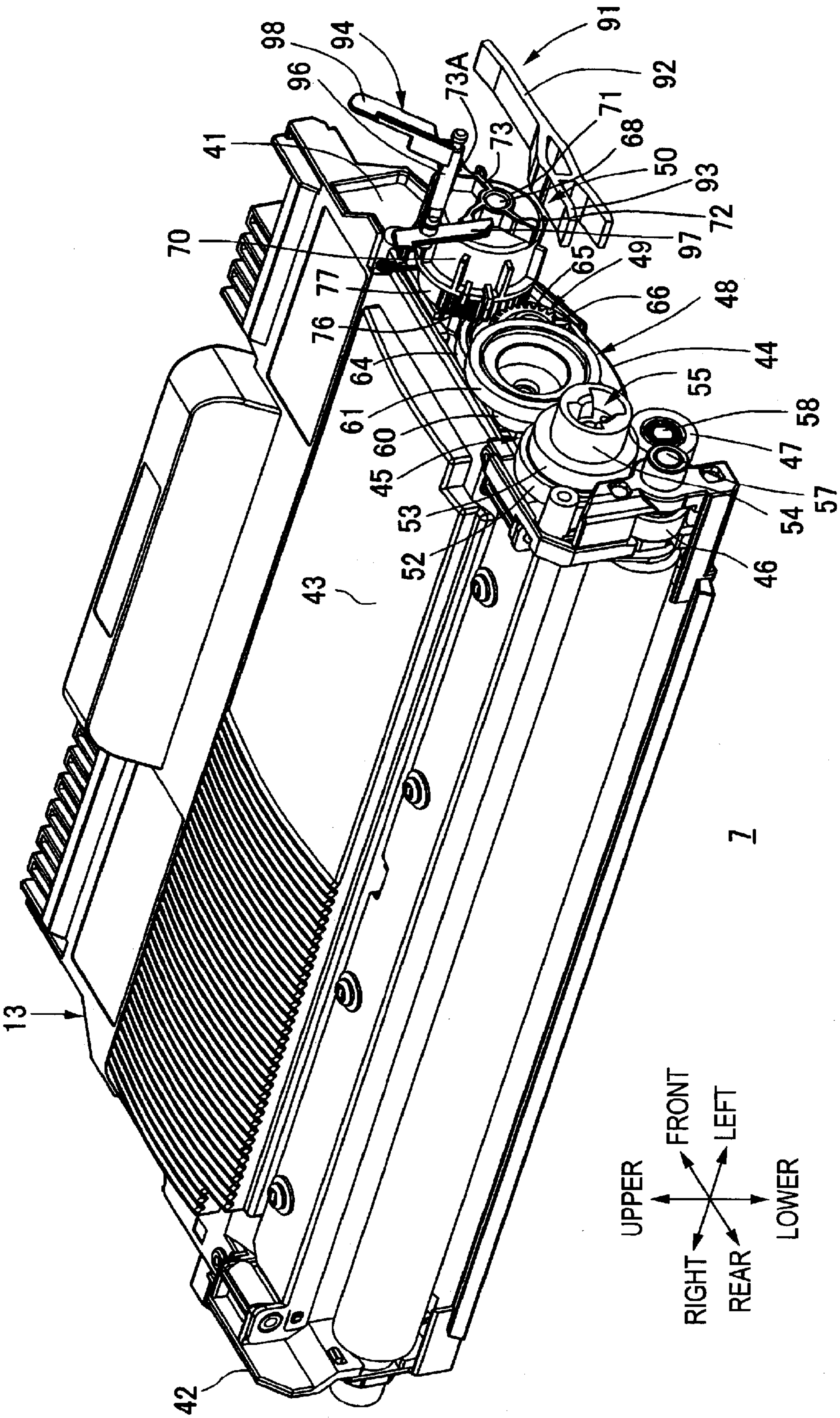
FIG. 10A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LOWER
RIGHT
REAR
42

FIG. 10B

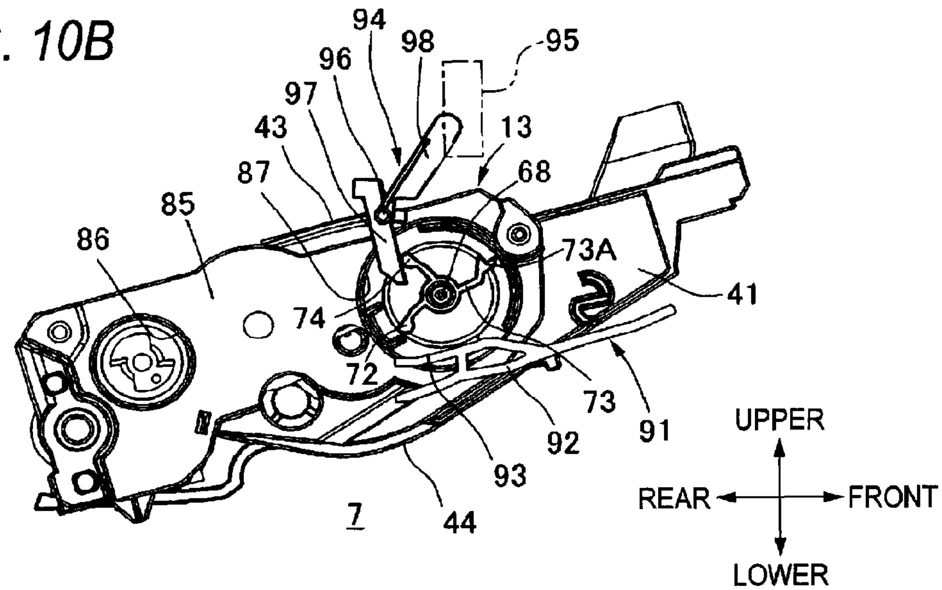


FIG. 10C

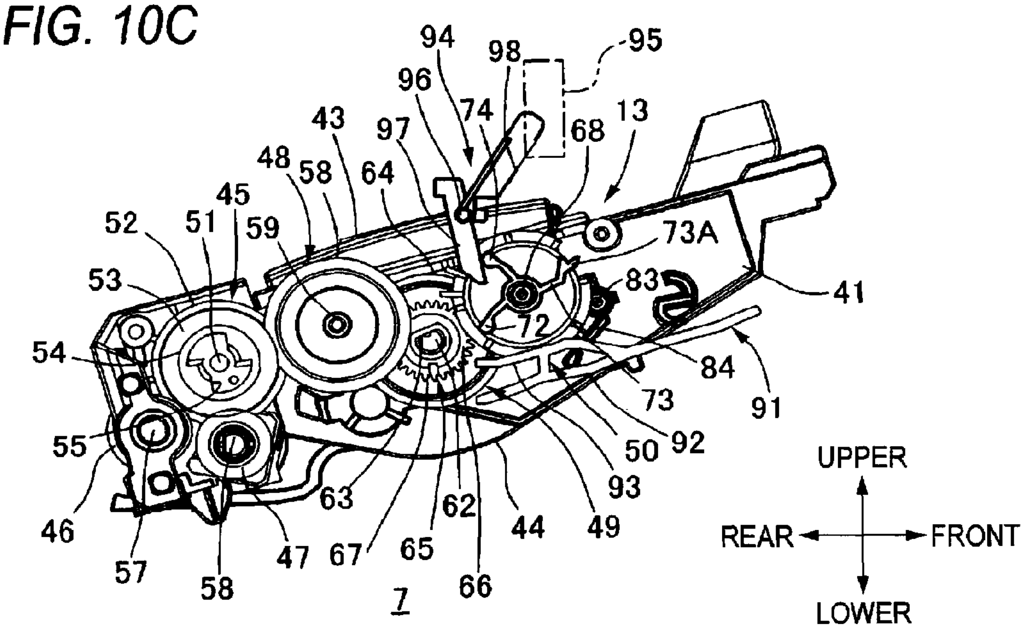
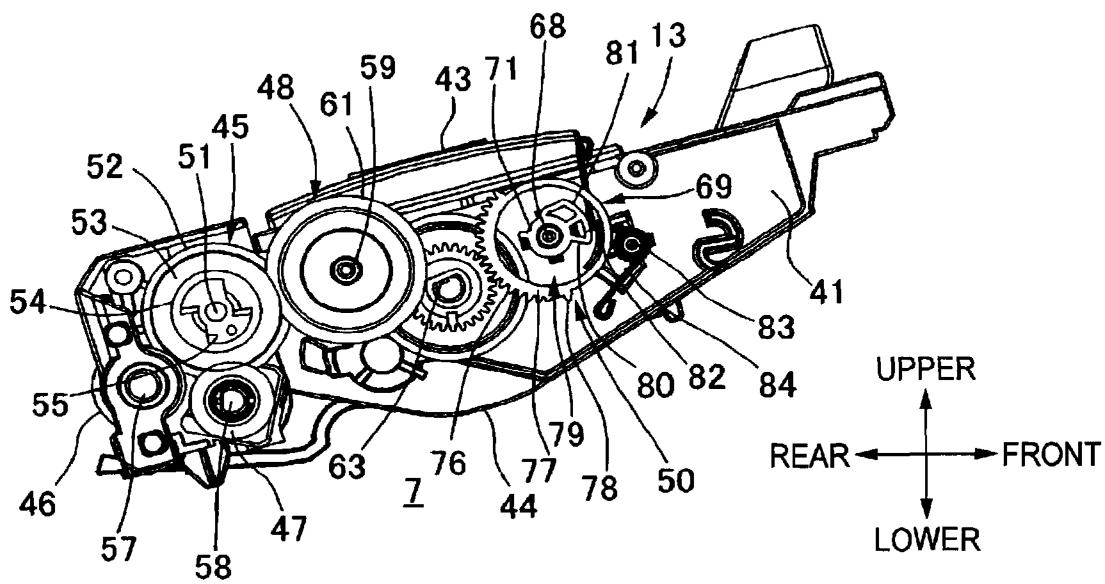


FIG. 10D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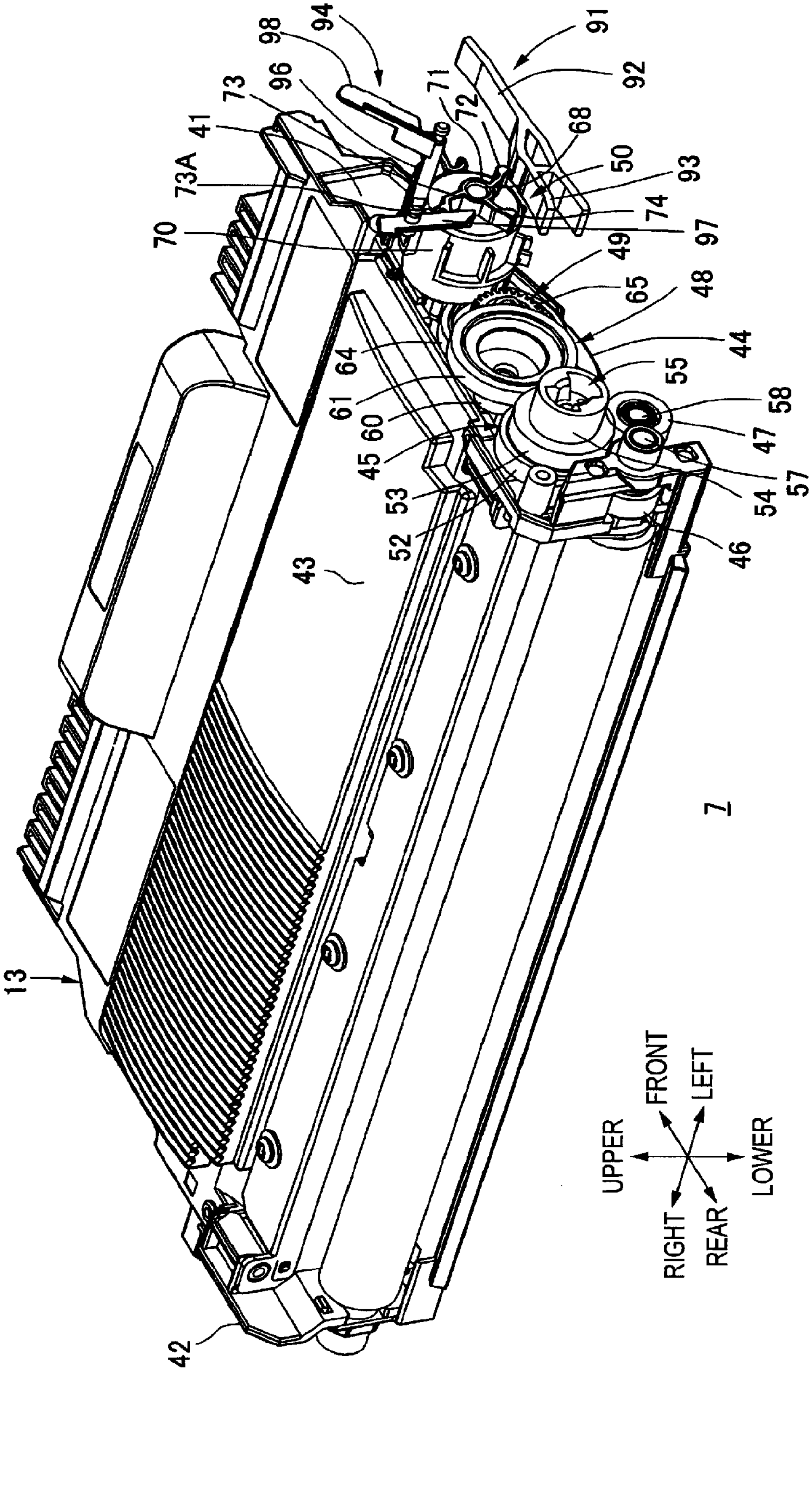
LOWER

FIG. 11A



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LEFT
LOWER
RIGHT
REAR

FIG. 11B

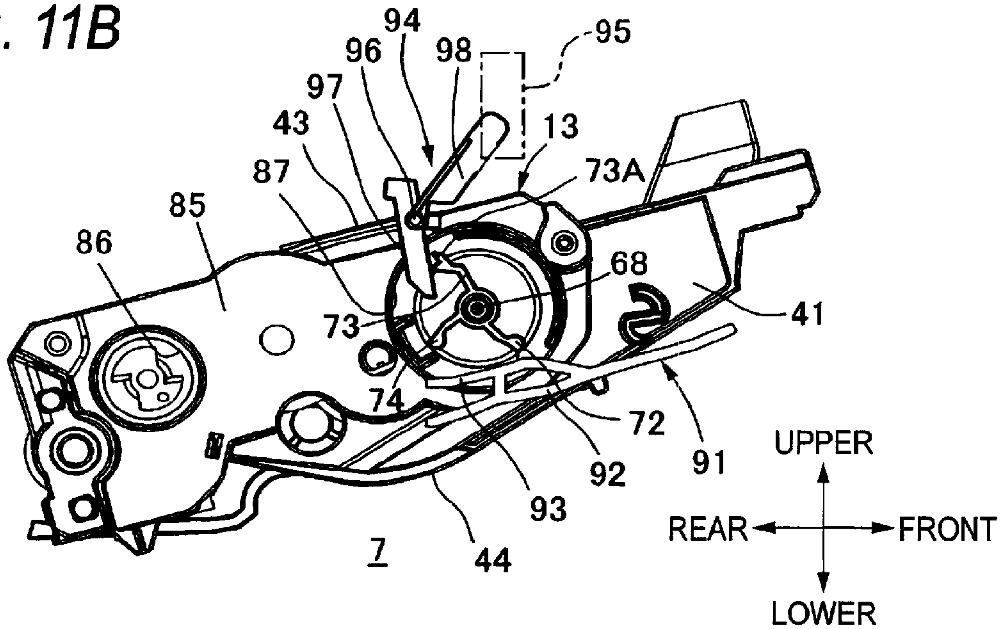


FIG. 11C

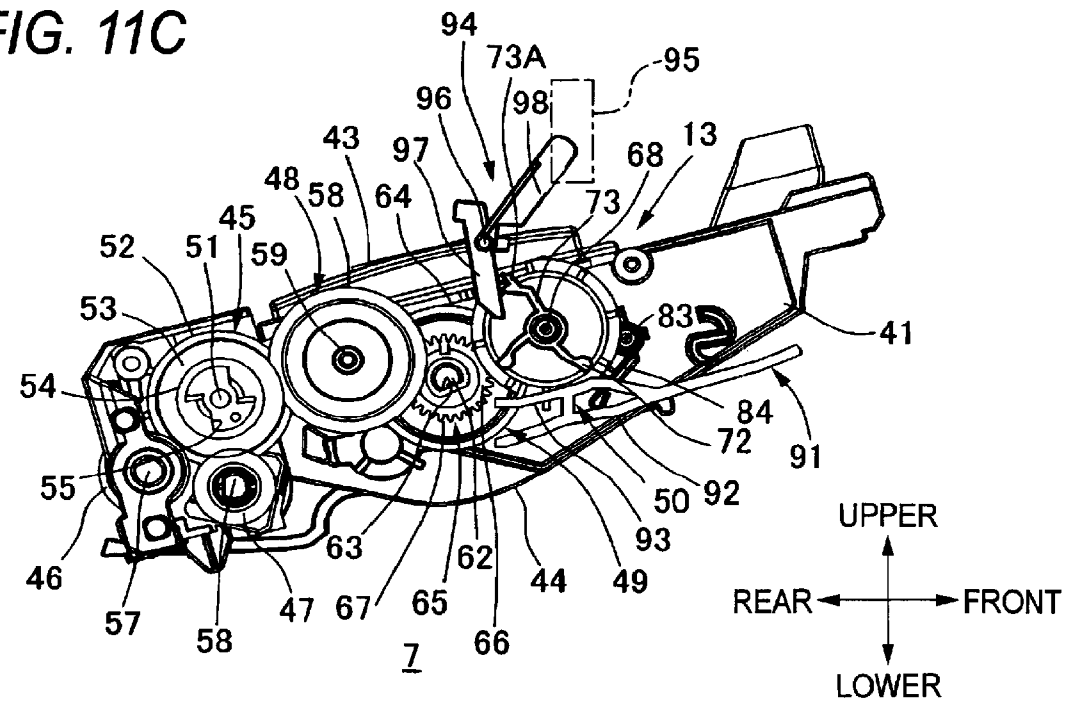
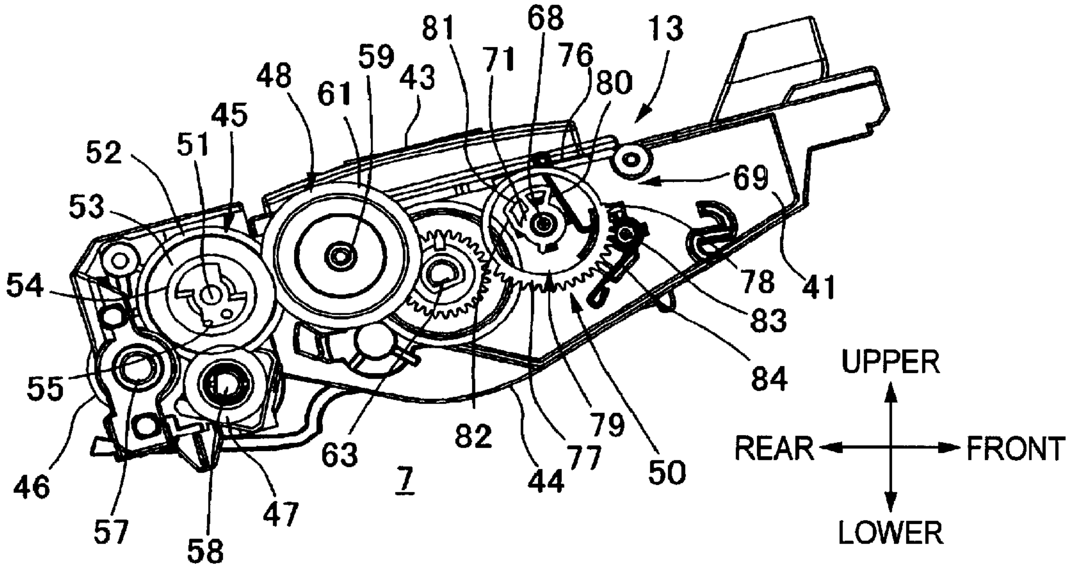


FIG. 11D



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UPPER
REAR
FRONT
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LOWER
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FIG. 12

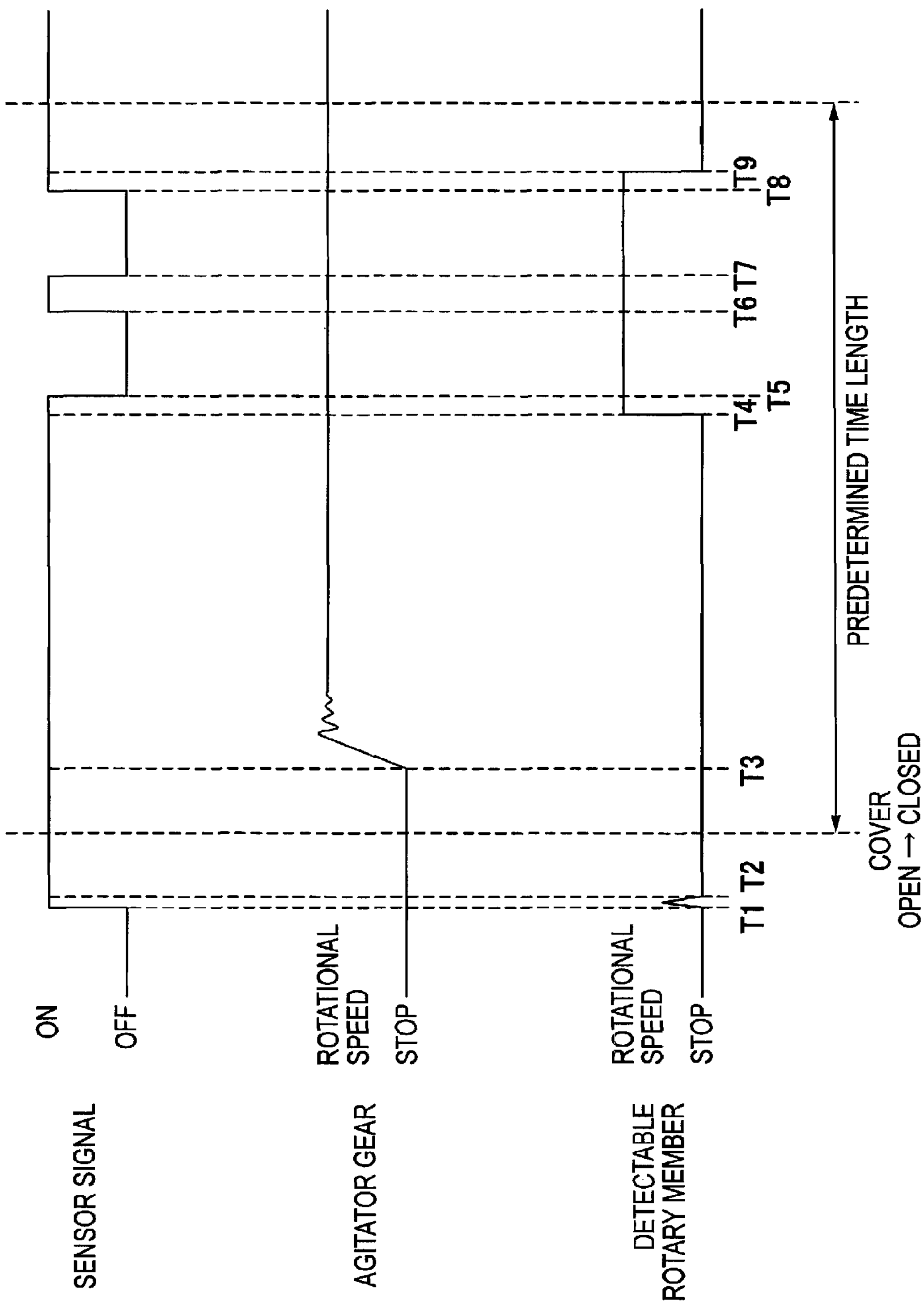

SENSOR SIGNAL
ON
OFF
AGITATOR GEAR
ROTATIONAL SPEED
STOP
DETECTABLE ROTARY MEMBER
ROTATIONAL SPEED
STOP
T1 T2
T3
T4
T5
T6 T7
T8
T9
COVER OPEN → CLOSED
PREDETERMINED TIME LENGTH

FIG. 13

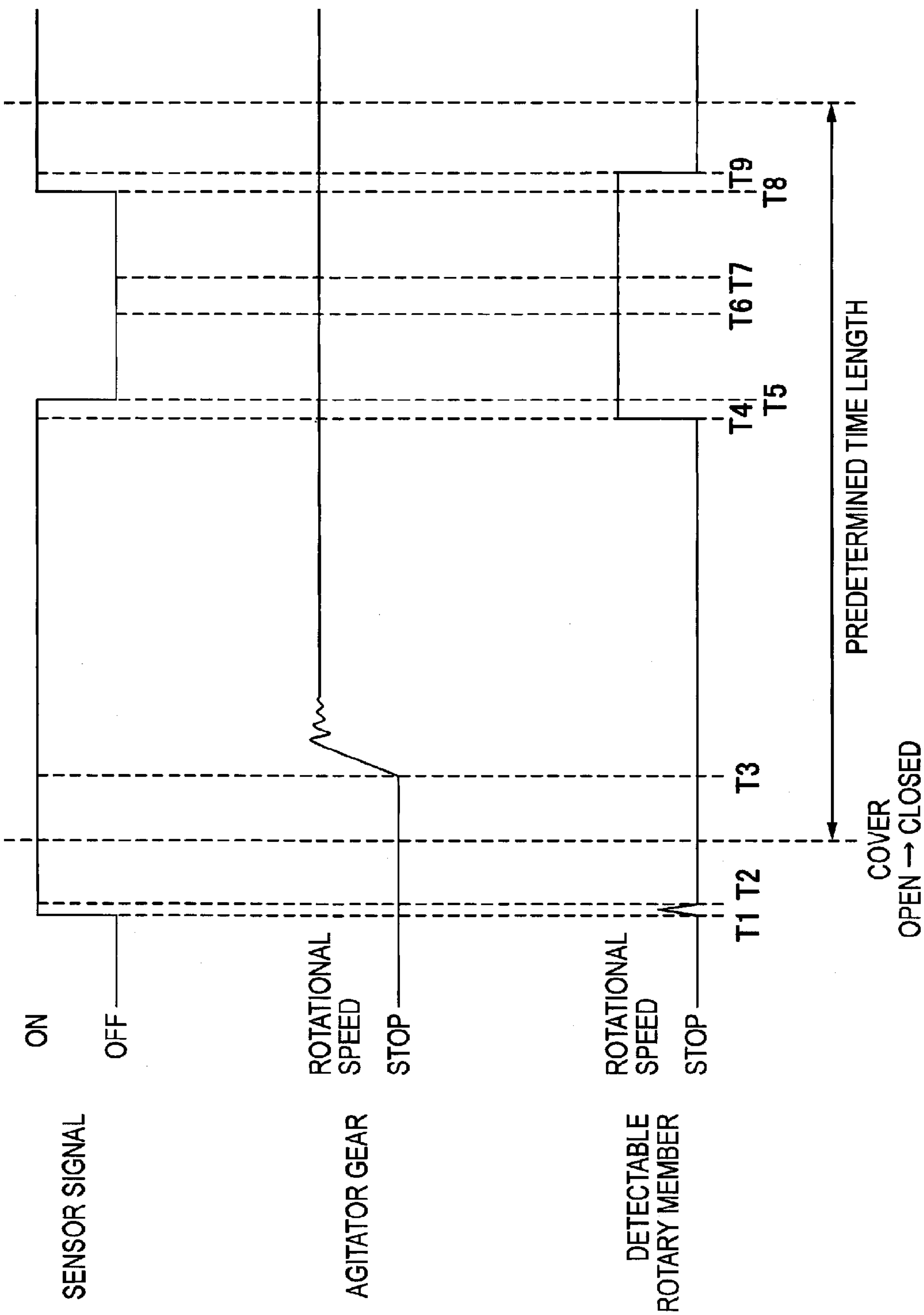

SENSOR SIGNAL
ON
OFF
AGITATOR GEAR
ROTATIONAL SPEED
STOP
DETECTABLE ROTARY MEMBER
ROTATIONAL SPEED
STOP
T1 T2
T3
T4
T5
T6 T7
T8
T9
COVER OPEN → CLOSED
PREDETERMINED TIME LENGTH

FIG. 14

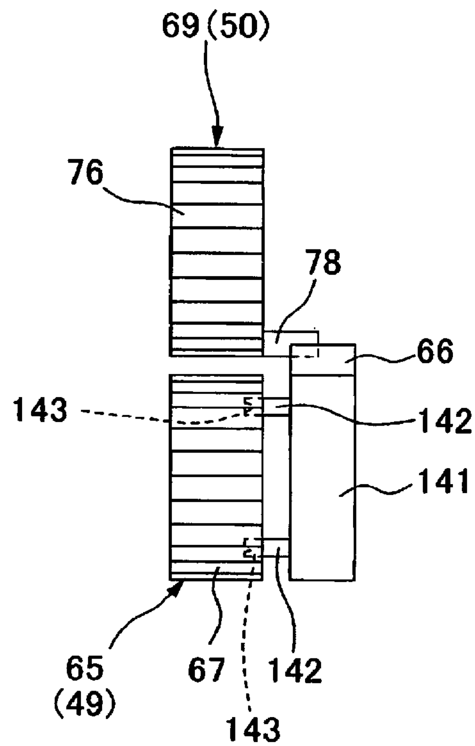


FIG. 15

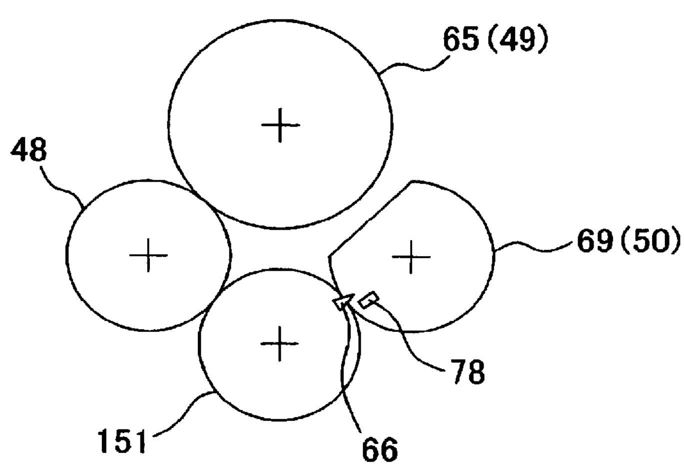


FIG. 16

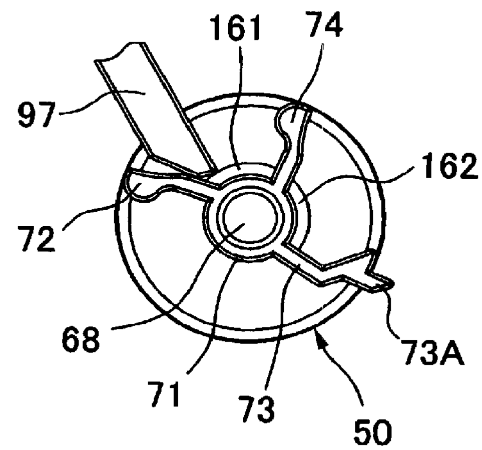


FIG. 17

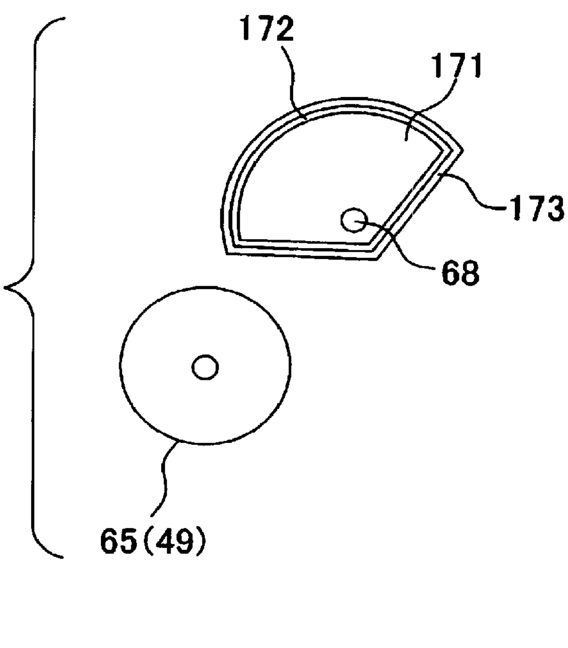


FIG. 18

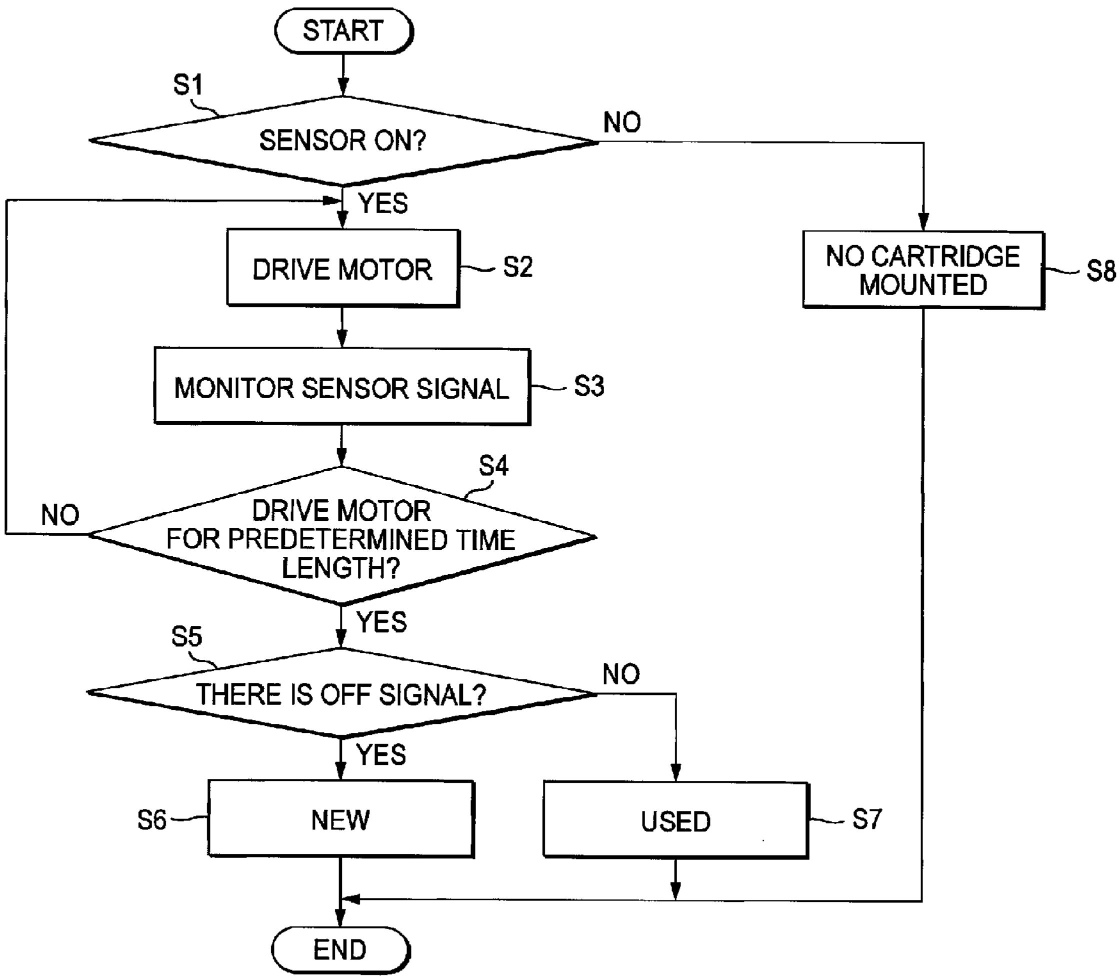
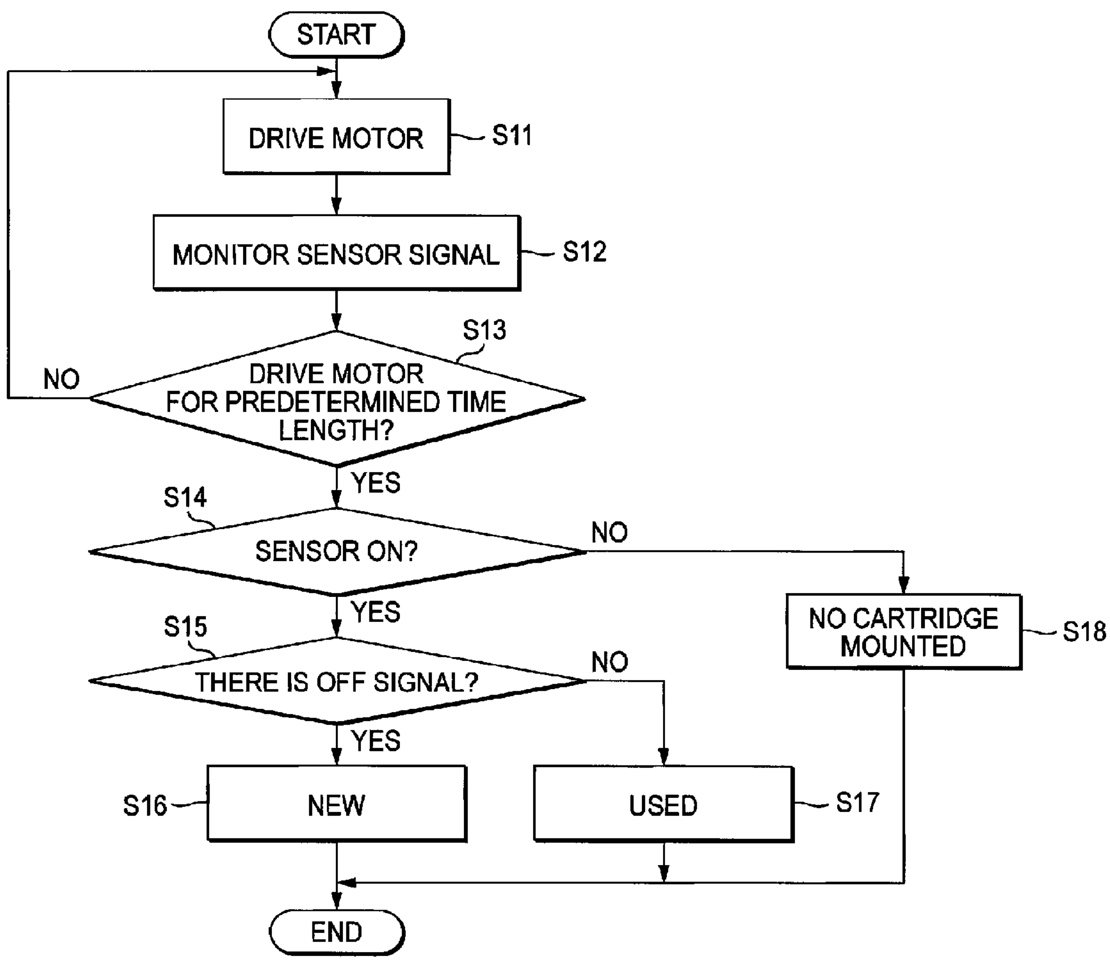

START
S1
SENSOR ON?
NO
YES
DRIVE MOTOR
S2
NO CARTRIDGE MOUNTED
S8
MONITOR SENSOR SIGNAL
S3
S4
NO
DRIVE MOTOR FOR PREDETERMINED TIME LENGTH?
YES
S5
THERE IS OFF SIGNAL?
NO
YES
S6
NEW
USED
S7
END

FIG. 19


START
DRIVE MOTOR
S11
MONITOR SENSOR SIGNAL
S12
S13
DRIVE MOTOR
FOR PREDETERMINED TIME
LENGTH?
NO
YES
S14
SENSOR ON?
NO
YES
S15
THERE IS OFF SIGNAL?
NO
YES
NO CARTRIDGE
MOUNTED
S18
S16
NEW
USED
S17
END

DETECTING A DEVELOPING CARTRIDGE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 13/053,074, filed on Mar. 21, 2011, which claims priority from Japanese Patent Application No. 2010-068573, filed on Mar. 24, 2010, the entire subject matter disclosures of which are incorporated herein by reference.

TECHNICAL FIELD

Aspects of the present invention relate to a developing cartridge which is detachably mounted in an apparatus main body of an image forming apparatus such as a laser printer.

BACKGROUND

In an image forming apparatus such as a laser printer, a developing cartridge is detachably mounted in an apparatus main body. Toner is accommodated within the developing cartridge. When toner in the developing cartridge is used up, the developing cartridge is removed from the apparatus main body. Then, a new developing cartridge is mounted in the apparatus main body. In addition, when a sheet is jammed in the apparatus main body, there may be a situation in which the developing cartridge is removed from the apparatus main body, and after the jam is resolved, the developing cartridge is remounted in the apparatus main body.

In this type of image forming apparatuses, there is proposed an image forming apparatus in which a detection gear having an abutment projection is provided on a side surface of a developing cartridge, and when the developing cartridge is mounted in an apparatus main body, information on the developing cartridge is obtained based on rotation of the detection gear.

The detection gear is provided to be rotatable about an axis which extends in a direction which orthogonally intersects the side surface of the developing cartridge. Gear teeth are formed on a circumferential surface of the detection gear except a part thereof. Namely, the detection gear is a partly non-tooth gear. In addition, a transmission gear is provided on the side surface of the developing cartridge to be rotatable about an axis which extends in parallel to the axis of the detection gear with a space therebetween. Gear teeth are formed on a circumferential surface of the transmission gear so as to extend along the full circumference thereof. With a new developing cartridge, the gear teeth of the detection gear mesh with the gear teeth of the detection gear. When the developing cartridge is mounted in the apparatus main body, a driving force of a motor is inputted into the transmission gear, and the driving force is transmitted from the detection gear to the detection gear via the gear teeth of these gears.

With the driving force so transmitted, the detection gear rotates, and the abutment projection moves as the detection gear rotates. A sensor is provided in the apparatus main body for detecting a passage of the abutment projection. Then, whether the developing cartridge is new or used is determined based on whether or not the passage of the abutment projection is detected by the sensor within a predetermined length of time after the start of driving of the motor. When the detection gear continues to rotate so that a non-tooth portion of the detection gear comes to oppose the gear teeth of the transmission gear, the mesh engagement of the gear teeth of the transmission gear with the gear teeth of the detection gear is released, whereby the detection gear stops rotating (for example, see JP-A-2006-267994).

SUMMARY

Accordingly, an aspect of the present invention is to provide a developing cartridge which is more convenient than the conventional one while including a detectable rotary member such as the detection gear.

According to an illustrative embodiment of the present invention, there is provided a developing cartridge which is detachably mounted in an apparatus main body of an image forming apparatus, the developing cartridge comprising: a housing including a first side wall and a second side wall which are provided to oppose each other, the housing configured to accommodate developer therein; a receiving member provided on an outer side of the first side wall to be rotatable about a first axis which extends in an opposing direction of the first side wall and the second side wall, the receiving member configured to couple with a driving force output member provided in the apparatus main body to receive a driving force from the driving force output member; a developing roller provided between the first side wall and the second side wall to be rotatable about a second axis which extends in parallel to the first axis with a space therebetween, the developing roller configured to rotate by the driving force received by the receiving member; and a detectable rotary member provided on the outer side of the first side wall to be rotatable about a third axis which extends in parallel to the first axis with a space therebetween, and including a detectable portion, which is a detection target to be detected by a detection member provided in the apparatus main body, and a contact portion which is provided away from the detectable portion in a rotational direction about the third axis, the detectable rotary member configured to rotate from a retreat position to an initial position by the contact portion contacting an interference member fixed in the apparatus main body in a process of mounting the developing cartridge into the apparatus main body, the initial position being where the detectable rotary member is rotated by the driving force received by the receiving member.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects of the present invention will become more apparent and more readily appreciated from the following description of illustrative embodiments of the present invention taken in conjunction with the attached drawings, in which:

FIG. **1** is a sectional view of a laser printer in which a developing cartridge according to an illustrative embodiment of the present invention is mounted;

FIG. **2**A is a perspective view of the developing cartridge as viewed from the left rear thereof;

FIG. **2**B is a left side view of the developing cartridge shown in FIG. **2**A with a gear cover attached;

FIG. **2**C is a left side view of the developing cartridge shown in FIG. **2**A;

FIG. **2**D is a left side of the developing cartridge shown in FIG. **2**A with a part of a detectable rotary member detached;

FIG. **2**E is a perspective view of a part of the developing cartridge shown in FIG. **2**A in an enlarged manner;

FIG. **3**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state immediately after the developing cartridge is mounted in a body casing;

FIG. **3**B is a left side view of the developing cartridge shown in FIG. **3**A with a gear cover attached;

FIG. **3**C is a left side view of the developing cartridge shown in FIG. **3**A;

FIG. **3**D is a left side of the developing cartridge shown in FIG. **3**A with a part of the detectable rotary member detached;

FIG. **4**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **3**A;

FIG. **4**B is a left side view of the developing cartridge shown in FIG. **4**A with the gear cover attached;

FIG. **4**C is a left side view of the developing cartridge shown in FIG. **4**A;

FIG. **4**D is a left side of the developing cartridge shown in FIG. **4**A with a part of the detectable rotary member detached;

FIG. **5**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **4**A;

FIG. **5**B is a left side view of the developing cartridge shown in FIG. **5**A with the gear cover attached;

FIG. **5**C is a left side view of the developing cartridge shown in FIG. **5**A;

FIG. **5**D is a left side of the developing cartridge shown in FIG. **5**A with a part of the detectable rotary member detached;

FIG. **6**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **5**A;

FIG. **6**B is a left side view of the developing cartridge shown in FIG. **6**A with the gear cover attached;

FIG. **6**C is a left side view of the developing cartridge shown in FIG. **6**A;

FIG. **6**D is a left side of the developing cartridge shown in FIG. **6**A with a part of the detectable rotary member detached;

FIG. **7**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **6**A;

FIG. **7**B is a left side view of the developing cartridge shown in FIG. **7**A with the gear cover attached;

FIG. **7**C is a left side view of the developing cartridge shown in FIG. **7**A;

FIG. **7**D is a left side of the developing cartridge shown in FIG. **7**A with a part of the detectable rotary member detached;

FIG. **7**E is a perspective view of a part of the developing cartridge shown in FIG. **7**A in an enlarged manner;

FIG. **8**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **7**A;

FIG. **8**B is a left side view of the developing cartridge shown in FIG. **8**A with the gear cover attached;

FIG. **8**C is a left side view of the developing cartridge shown in FIG. **8**A;

FIG. **8**D is a left side of the developing cartridge shown in FIG. **8**A with a part of the detectable rotary member detached;

FIG. **9**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **8**A;

FIG. **9**B is a left side view of the developing cartridge shown in FIG. **9**A with the gear cover attached;

FIG. **9**C is a left side view of the developing cartridge shown in FIG. **9**A;

FIG. **9**D is a left side of the developing cartridge shown in FIG. **9**A with a part of the detectable rotary member detached;

FIG. **10**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **9**A;

FIG. **10**B is a left side view of the developing cartridge shown in FIG. **10**A with the gear cover attached;

FIG. **10**C is a left side view of the developing cartridge shown in FIG. **10**A;

FIG. **10**D is a left side of the developing cartridge shown in FIG. **10**A with a part of the detectable rotary member detached;

FIG. **11**A is a perspective view of the developing cartridge as viewed from the left rear thereof which shows a state following the state shown in FIG. **10**A;

FIG. **11**B is a left side view of the developing cartridge shown in FIG. **11**A with the gear cover attached;

FIG. **11**C is a left side view of the developing cartridge shown in FIG. **11**A;

FIG. **11**D is a left side of the developing cartridge shown in FIG. **11**A with a part of the detectable rotary member detached;

FIG. **12** is a timing chart showing operation timings of a main part when mounting of the developing cartridge is detected and the developing cartridge mounted is detected as new;

FIG. **13** is a timing chart showing other operation timings (operation timings with a third detection portion omitted) of the main part when mounting of the developing cartridge is detected and the developing cartridge mounted is detected as new;

FIG. **14** is a plan view showing a configuration (Modified Example 1) in which an engagement portion is formed separately from an agitator gear;

FIG. **15** is an illustrative side view showing a configuration (Modified Example 2) in which an engagement portion is formed on a gear different from an agitator gear;

FIG. **16** is a side view showing a configuration (Modified Example 3) in which a first detectable portion and a second detectable portion are integrated;

FIG. **17** is an illustrative side view showing a configuration (Modified Example 4) which employs alternative of a non-tooth portion of a detectable rotary member;

FIG. **18** is an example of a flowchart for detecting mounting of the developing cartridge and detecting whether or not the developing cartridge mounted is new (an example in which whether or not the developing cartridge is mounted is determined before the driving of a motor); and

FIG. **19** is another example of a flowchart for detecting mounting of the developing cartridge and detecting whether or not the developing cartridge mounted is new (an example in which whether or not the developing cartridge is mounted is determined after the driving of a motor).

DETAILED DESCRIPTION

Hereinafter, an illustrative embodiment of the present invention will be described in detail by reference to the accompanying drawings.

1. Overall Configuration of Laser Printer

As shown in FIG. **1**, a laser printer **1** (an example of an image forming apparatus) includes a body casing **2** (an example of an apparatus main body). A cartridge mount/removal opening **3** is formed in one side wall of the body casing **2**, and a front cover **4** is provided for opening and closing the cartridge mount/removal opening **3**.

Note that in the following description, the side of the laser printer **1** where the front cover **4** is provided is referred to as a front side thereof. Upper, lower, left and right sides of the laser printer are so determined based a situation in which the laser printer **1** is viewed from the front side thereof. In addition, a front and rear of a developing cartridge **7** is so determined based on a situation in which the developing cartridge **7** is mounted in the body casing **2**, and upper, lower, left and right sides thereof are so determined based on a situation in which the developing cartridge **7** is viewed from the front side thereof.

A process cartridge **5** is mounted in the body casing **2** in a position which is situated slightly further forwards than a center thereof. With the front cover **4** opened, the process cartridge **5** is mounted in and removed from the body casing **2** via the cartridge mount/removal opening **3**.

The process cartridge **5** includes a drum cartridge **6** and a developing cartridge **7** which is detachably attached in the drum cartridge **7**.

The drum cartridge **6** includes a drum frame **8**. A photosensitive drum **9** is held rotatably at a rear end portion of the drum frame **8**. In addition, a charger **10** and a transfer roller **11** are held in the drum frame **8**. The charger **10** and the transfer roller **11** are provided at the rear of and below the photosensitive drum **9**.

A portion of the drum frame **8** situated further forwards than the photosensitive drum **9** is configured as a developing cartridge attachment portion **12**, and the developing cartridge **7** is mounted in this developing cartridge attachment portion **12**.

The developing cartridge **7** includes a housing **13** which accommodates toner therein. A toner accommodation compartment **14** and a developing compartment **15**, which communicate with each other, are formed in an interior of the housing **13** so as to be situated adjacent to each other in a front-rear direction.

An agitator **16** is provided in the toner accommodation compartment **14** to be rotatable about an agitator rotating axis **17** which extends in a left-right direction. Toner accommodated in the toner accommodation compartment **14** is supplied from the toner accommodation compartment **14** to the developing compartment **15** while being agitated by rotation of the agitator **16**.

A developing roller **18** and a supply roller **19** are provided in the developing compartment **15** to be rotatable about a developing rotating axis **20** and a supplying rotating axis **21**, respectively, which extend in the left-right direction. The developing roller **18** is provided so that a part of a circumferential surface thereof is exposed from a rear end portion of the housing **13**. The developing cartridge **7** is attached in the drum cartridge **6** so that the circumferential surface of the developing roller **18** is brought into contact with a circumferential surface of the photosensitive drum **9**. The supply roller **19** is provided so that a circumferential surface thereof is brought into contact with the circumferential surface of the developing roller **18** from the front and below the developing roller **18**. Toner in the developing compartment **15** is supplied to the circumferential surface of the developing roller **18** by the supply roller **19** and is carried on the circumferential surface of the developing roller **18** in the form of a thin layer.

An exposing unit **22** which emits a laser beam is provided above the process cartridge **5** in the body casing **2**.

When forming an image, the photosensitive drum **9** is rotated clockwise as viewed in FIG. **1** at a constant speed. The circumferential surface (the surface) of the photosensitive drum **9** is charged uniformly by discharge from the charger **10**. On the other hand, a laser beam is emitted from the exposing unit **22** based on image data received from a personal computer (not shown) which is connected to the printer **1**. The laser beam passes between the charger **10** and the developing cartridge **7** and is shone on to the circumferential surface of the photosensitive drum **9** which is uniformly positively charged so as to expose the circumferential surface of the photosensitive drum **9** selectively. By this exposure, electric charges are selectively removed from the portion of the photosensitive drum **9** which is so exposed, whereby an electrostatic latent image is formed on the circumferential surface of the photosensitive drum **9**. When the latent image comes to confront the developing roller **18** as a result of rotation of the photosensitive drum **9**, toner is supplied to the latent image from the developing roller **18**, whereby a toner image is formed on the circumferential surface of the photosensitive drum **9**.

A sheet feeding cassette **23** is provided at a bottom portion of the body casing **2**. A pickup roller **24** is provided above the sheet feeding cassette **23** for feeding sheets out of the sheet feeding cassette **23**.

In addition, a conveying path **25**, which has an S-shape as viewed from a side thereof, is formed in the body casing **2**. This conveying path **25** extends from the sheet feeding cassette **23** to reach a sheet discharging tray **26** which is formed on an upper surface of the body casing **2** by way of a nip between the photosensitive drum **9** and the transfer roller **11**. Provided on the conveying path **25** are a separation roller **27** and a separation pad **28**, which are provided so as to oppose each other, a pair of sheet feeding rollers **29**, a pair of registration rollers **30** and a pair sheet discharging rollers **31**.

Sheets P which are fed out of the sheet feeding cassette **23** are fed in between the separation roller **27** and the separation pad **28** so as pass therebetween sheet by sheet. Thereafter, the sheet P is conveyed towards the registration rollers by the sheet feeding rollers **29**. Then, the sheet P is registered by the registration rollers **30** and is thereafter conveyed towards between the photosensitive drum **9** and the transfer roller **11** by the registration rollers **30**.

When the toner image comes to face the sheet P passing between the photosensitive drum **9** and the transfer roller **11** as a result of rotation of the photosensitive drum **9**, the toner image on the circumferential surface of the photosensitive drum **9** is electrically attracted by the transfer roller **11** so as to be transferred to the sheet P.

A fixing unit **32** is provided on the conveying path **25** in a position situated further downstream in the conveying direction of the sheet P than the transfer roller **11**. The sheet P to which the toner image is transferred is conveyed along the conveying path **25** and passes the fixing unit **32**. In the fixing unit **32**, the toner image is transformed into an image which is fixed on the sheet P by virtue of heat and pressure.

This printer **1** has, as operation modes, a single-side printing mode in which an image (a toner image) is formed on one side of a sheet P and a double-side printing mode in which after an image is formed on one side a sheet P, an image is formed on the other side of the sheet P which is opposite to the one side where the image has already been formed.

In the single-side printing mode, the sheet P on one side of which the image is formed is discharged into the sheet discharging tray **26** by the sheet discharging rollers **31**.

A reversely conveying path **33** is formed in the body casing **2** so as to realize the double-side printing mode. The reversely conveying path **33** starts from a position in proximity to the sheet discharging rollers **31**, extends between the conveying path **25** and the sheet feeding cassette **23** and is finally connected to a portion on the conveying path **25** which is situated between the sheet feeding rollers **29** and the registration rollers **30**. Provided on the reversely conveying path **33** are a pair of first reversely conveying rollers **34** and a pair of second reversely conveying rollers **35**.

In the double-side printing mode, after an image is formed on one side of a sheet P, the sheet P is not discharged into the sheet discharging tray **26** but is fed into the reversely conveying path **33**. Then, the sheet P is conveyed along the reversely conveying path **33** by the first reversely conveying rollers **34** and the second reversely conveying rollers **35** and is turned inside out so as to be fed into the conveying path **25** in a posture in which the other side of the sheet P on which no image is formed faces the circumferential surface of the photosensitive drum **9**. Then, an image is formed on the other side of the sheet P, whereby the formation of the images on both the sides of the sheet P is performed.

2. Developing Cartridge

(1) Housing

As shown in FIG. **2**A, the housing **13** of the developing cartridge **7** has a box shape which is opened at a rear side. Specifically, the housing **13** has a first side wall **41** and a second side wall **42**. The first side wall **41** and a second side wall **42** oppose each other in the left-right direction. The first and second side walls **41**, **42** each have a plate-like shape and extend in the front-rear direction. In addition, the housing **13** has an upper wall **43** and a lower wall **44** which extend between upper end portions and lower end portions of the first side wall **41** and the second side wall **42**, respectively. A front end portion of the lower wall **44** extends upwards while being curved and is connected to a front end portion of the upper wall **43**.

(2) Gears

As shown in FIGS. **2**A, **2**C, an input gear **45** (an example of a receiving member), a developing gear **46**, a supply gear **47**, an intermediate gear **48**, an agitator gear **49** (an example of an intermediate rotary member), and a detectable rotary member **50** are provided on an outer side (a left-hand side) of the first side wall **41** which is situated at a left-hand side of the housing **13**.

(2-1) Input Gear

The input gear **45** is provided at an upper portion of a rear end of the first side wall **41**. The input gear **45** is provided to be rotatable about an input gear rotation shaft **51** which extends in the left-right direction. The input gear rotation shaft **51** is held in the first side wall **41** so as not to rotate.

The input gear **45** has integrally a large-diameter gear portion **52**, a small-diameter gear portion **53** and a coupling portion **54**. The large-diameter gear portion **52**, the small-diameter gear portion **53** and the coupling portion **54** are aligned in that order from the first side wall **41** side.

The large-diameter gear portion **52** has a disc shape whose axis coincides with the input gear rotation shaft **51**. Gear teeth (for example, inclined gear teeth) are formed on a circumferential surface of the large-diameter gear portion **52** along the full circumference thereof.

The small-diameter gear portion **53** has a disc shape whose axis coincides with the input gear rotation shaft **51** and is formed smaller in diameter than the large-diameter gear portion **52**. Gear teeth (for example, inclined gear teeth) are formed on a circumferential surface of the small-diameter gear portion **53** along the full circumference thereof.

The coupling portion **54** has a disc shape whose axis coincides with the input gear rotation shaft **51** and has a circumferential surface which is smaller in diameter than the circumferential surface of the small-diameter gear portion **53**. A coupling recess portion **55** is formed in a left-hand side surface of the coupling portion **54**. A distal end portion of a driving force output member **56** (refer to FIG. **2**A) which is provided in the body casing **2** is inserted into the coupling recess portion **55** in such a state that the developing cartridge **7** is mounted in the body casing **2**.

The driving force output member **56** is provided so as to advance and retreat in the left-right direction. With the developing cartridge **7** mounted in the body casing **2**, the driving force output member **56** advances rightwards along an axis of the input gear rotational shaft **51**, so that the distal end portion thereof is inserted into the coupling recess portion **55**, whereby the driving force output member **56** and the coupling recess portion **55** are coupled together so as not to rotate relatively. Therefore, when the driving force output member **56** is rotated by a driving force from a motor (not shown) in the body casing **2**, a rotation force of the driving force output member **56** is received by the input gear **45**, whereby the input gear **45** rotates together with the driving force output member **56** Specifically, the coupling recess portion **55** has a receiving surface which contacts the driving force output member **56** to receive the rotation force of the driving force output member **56**.

(2-2) Developing Gear

The developing gear **46** is provided at the rear of and below the input gear **45**. The developing gear **46** is attached to a developing roller shaft **57** that the developing roller **18** possesses so as not to rotate relatively. The developing roller shaft **57** is rotatably provided in the first side wall **41**, and an axis of the developing roller shaft **57** constitutes a developing rotation axis **20** (refer to FIG. **1**) (an example of a second axis) which is a rotation axis of the developing roller **18**. Gear teeth are formed on a circumferential surface of the developing gear **46** along the full circumference thereof, and the gear teeth mesh with the gear teeth of the large-diameter gear portion **52** of the input gear **45**.

(2-3) Supply Gear

The supply gear **47** is provided below the input gear **45**. The developing gear **47** is attached to a supply roller shaft **58** that the supply roller **19** (refer to FIG. **1**) possesses so as not to rotate relatively. The supply roller shaft **58** is rotatably provided in the first side wall **41**, and an axis of the supply roller shaft **58** constitutes a supplying rotation axis **20** (refer to FIG. **1**) which is a rotation axis of the supply roller **19**. Gear teeth are formed on a circumferential surface of the supply gear **47** along the full circumference thereof, and the gear teeth mesh with the gear teeth of the small-diameter gear portion **53** of the input gear **45**.

(2-4) Intermediate Gear

The intermediate gear **48** is provided in front of the input gear **45**. The intermediate gear **48** is provided to be rotatable about an intermediate gear rotation shaft **59** which extends in the left-right direction. The intermediate gear rotation shaft **59** is held in the first side wall **41** so as not to rotate.

The intermediate gear **48** integrally has a small-diameter portion **60** having a disc shape with a relatively small outside diameter and a large-diameter portion **61** having a cylindrical shape with a relatively large outside diameter. The small-diameter portion **60** and the large-diameter portion **61** are aligned in that order from the first side wall **41** side. Axes of the small-diameter portion **60** and the large-diameter portion **61** coincide with an axis of the intermediate gear rotation shaft **59**.

Gear teeth are formed on a circumferential surface of the small-diameter portion **60** along the full circumference thereof.

Gear teeth are formed on an circumferential surface of the large-diameter portion **61** along the full circumference thereof. The gear teeth of the large-diameter portion **61** mesh with the gear teeth of the small-diameter gear portion **53** of the input gear **45**.

(2-5) Agitator Gear

The agitator gear **49** is provided at the front of and below the intermediate gear **48**. As shown in FIG. **2**C, the agitator gear **49** is attached to an agitator rotation shaft **62** so as not to rotate relatively. Specifically, the agitator rotation shaft **62** penetrates the first side wall **41** in the left-right direction. In the housing **13**, the agitator **16** is attached to the agitator rotation shaft **62**. A part of a circumferential surface of a left end portion of the agitator rotation shaft **62** is cut out so that the left end portion of the agitator rotation shaft **62** has a D-shape as viewed from a side thereof. Then, on the outer side of the first side wall **41**, the left end portion of the agitator shaft rotation shaft **62** is inserted through a shaft insertion hole **63** having a D-shape as viewed from a side thereof which is formed so as to penetrate the agitator gear **49** in the left-right direction, whereby the agitator gear **49** is attached to the agitator rotation shaft **62** so as not to rotate relatively.

The agitator rotation shaft **62** is held rotatably in the first side wall **41** and the second side wall **42** (refer to FIG. **2**A). By being so held, the agitator **16** and the agitator gear **49** can rotate together with the agitator rotation shaft **62** about an axis of the agitator rotation shaft **62** which is an agitator rotation axis **17** (refer to FIG. **1**).

The agitator gear **49** integrally has a large-diameter gear portion **64**, a small-diameter gear portion **65** and an engagement portion **66**.

The large-diameter gear portion **64** has a disc shape whose axis coincides with the agitator rotation shaft **62**. Gear teeth are formed on a circumferential surface of the large-diameter gear portion **64** along the full circumference thereof. The gear teeth of the large-diameter gear portion **64** mesh with the gear teeth of the small-diameter portion of the intermediate gear **48**.

The small-diameter gear portion **65** is formed on a side of the large-diameter gear portion **64** which is opposite to a side thereof which opposes the first side wall **41**, has a disc shape whose axis coincides with the agitator rotation shaft **62** and is formed smaller in diameter than the large-diameter gear portion **64**. Gear teeth **67** (an example of first gear teeth) are formed on a circumferential surface of the small-diameter gear portion **65** along the full circumference thereof.

The engagement portion **66** is provided on a left end face of the small-diameter gear portion **65**. The engagement portion **66** has its height in the left-right direction and has a substantially triangular shape as viewed from a side thereof which extends in a radial direction of the small-diameter gear portion **65**. An end portion of the engagement portion **66** which is opposite to an end portion which opposes the agitator rotation shaft **62** has the same shape, when viewed from a side thereof, as one of the gear teeth **67** of the small-diameter gear portion **65** and is completely superimposed on one gear teeth **67** in the left-right direction.

(2-6) Detectable Rotary Member

The detectable rotary member **50** is provided in front of the agitator gear **49**. As shown in FIGS. **2**A to **2**D, the detectable rotary member **50** is provided to be rotatable about a rotation shaft **68** which extends in the left-right direction. The rotation shaft **68** is held in the first side wall **41** so as not to rotate.

The detectable rotary member **50** integrally has a partly non-tooth gear portion **69**, a raised portion **70**, a cylindrical portion **71**, a first detectable portion **72** (an example of a detectable portion), a second detectable portion **73** (an example of a contact portion) and a third detectable portion **74**.

As shown in FIG. **2**D, the partly non-tooth gear portion **69** has a double-cylinder shape whose axis coincides with the rotation shaft **68**.

Gear teeth **76** (an example of second gear teeth) are formed on a part of a circumferential surface of an outer cylindrical portion, that is, on an outermost circumferential surface of the partly non-tooth gear portion **69**. Specifically, a portion of the outermost circumferential surface of the partly non-tooth gear portion **69** whose central angle is about 230° is configured as a non-tooth portion **77** (an example of a cut-off mechanism), and the gear teeth **76** are formed on the other portion than the non-tooth portion **77** of the outermost circumferential surface whose central angle is about 130°. The gear teeth **76** have a gear width which is larger than that of the gear teeth **67** of the small-diameter gear portion **65** of the agitator gear **49**, and right end faces of the gear teeth **76** are provided on the same plane as right end faces of the gear teeth **67**. By adopting this configuration, left end portions of the gear teeth **76** do not mesh with the gear teeth **67** irrespective of the rotational position of the detectable rotary member **50**, and portions of the gear teeth **76** other than the left end portions mesh with the gear teeth **67** depending on the rotational position of the detectable rotary member **50**.

An engagement portion **78** is formed at an upstream side end portion in the rotating direction of the detectable rotary member **50** (counterclockwise in FIG. **2**D) of the non-tooth portion **77**. As shown in FIG. **2**E, the engagement portion **78** has a triangular shape as viewed from a side thereof and extends in a radial direction of the detectable rotary member **50** a length which is substantially the same as a height of the gear teeth **76**. The engagement portion **78** opposes a left end portion of the gear tooth **76** which is provided at a most downstream end in the rotating direction of the train of gear teeth **76** with a space defined therebetween in the rotating direction. Here, the engagement portion **78** does not oppose a right end portion of the gear tooth **76** in the rotating direction which is provided at the most downstream end in the rotating direction of the train of gear teeth **76** (specifically, a portion of the gear tooth **76** which is situated further rightwards than the left end portion (described above) which does not mesh with the gear teeth **67**). By this configuration, the engagement portion **78** is not brought into abutment with the gear teeth **67** of the small-diameter gear portion **65** of the agitator gear **49** irrespective of the rotational position of the detectable rotary member **50**. A rotational locus drawn by the engagement portion **78** when the detectable rotary member **50** rotates partly overlaps a rotational locus drawn by the engagement portion **66** when the agitator gear **49** rotates.

A pressed portion **79** is formed integrally on an inner cylindrical portion of the partly non-tooth gear portion **69**. The pressed portion **79** has a first radially extending portion **80** which extends radially from a circumferential surface of the inner cylindrical portion, a rotating direction extending portion **81** which extends in the rotating direction of the detectable rotary member **50** from a distal end portion of the first radially extending portion **80** towards a downstream side in the rotating direction and a second radially extending portion **82** which extends from a distal end portion of the rotating direction extending portion **81** towards the circumferential surface of the cylindrical portion. The first radially extending portion **80** extends in a direction which substantially orthogonally intersects a line which connects the gear tooth **76** of the gear teeth **76** which is provided at the most downstream side and the rotation shaft **68** (in detail, a direction which forms an angle of about 85° with respect to the line). In addition, the rotating direction extending portion **81** is formed to extend along an arc which is centered at an axis of the rotation shaft **68** and whose central angle is about 80° and opposes the non-tooth portion **77**.

The raised portion **70** has a cylindrical shape whose axis coincides with the rotation shaft **68**. A through hole (not shown) is formed in the raised portion **70** along its axis, and the rotation shaft **68** is inserted through the through hole.

The cylindrical portion **71** has a cylindrical shape and projects from a left end face of the raised portion **70**. A left end portion of the rotation shaft **68** is inserted into the cylindrical portion **71**.

The first detectable portion **72** extends from the cylindrical portion **71** in a radial direction of the raised portion **70** on a left end face of the raised portion **70**. In the rotating direction of the detectable rotary member **50**, a distal end portion of the first detectable portion **72** is provided substantially in the same position as a central portion of the train of gear teeth **76** of the partly non-tooth gear portion **69**.

The second detectable portion **73** extends from the cylindrical portion **71** on the left end face of the raised portion **70** in a substantially opposite direction to the direction in which the first detectable portion **72** extends. In the rotating direction of the detectable rotary member **50**, a distal end portion **73**A of the second detectable portion **73** is provided in the same position as a central portion of the non-tooth portion **77** of the partly non-tooth gear portion **69**. In addition, the distal end portion **73**A projects to the outside of a rotating locus drawn by the first detectable portion **72** when the detectable rotary member **50** rotates to thereby constitute an abutment portion with which an interference member **91** (described later) is brought into abutment.

The third detectable portion **74** is provided upstream of the first detectable portion **72** and downstream of the second detectable portion **73** in the rotating direction (counterclockwise in FIG. **2**B) of the detectable rotary member **50** and extends in a direction which orthogonally intersects the direction in which the first detectable portion **72** extends and a direction in which the third detectable portion **74** extends.

(3) Wire Spring

As shown in FIG. **2**D, a cylindrical boss **83** is formed on the outer side of the first side wall **41** so as to project therefrom in front of the detectable rotary member **50**. A wire spring **84** (an example of a holding member) is wound round the boss **83**. One end portion of the wire spring **84** is fixed to the first side wall **41**. The other end portion of the wire spring **84** extends towards the rotation shaft **68** of the detectable rotary member **50**. The wire spring **84** is curved at an intermediate portion along the length thereof. A distal end portion of the wire spring **84** is brought into abutment with the pressed portion **79** of the partly non-tooth gear portion **69** from a front side thereof to thereby press the pressed portion **79** to the rear.

(4) Gear Cover

As shown in FIG. **2**B, a gear cover **85** is attached to the outer side of the first side wall **41**. The gear cover **85** covers the input gear **45**, the supply gear **47**, the intermediate gear **48**, the agitator gear **49**, the detectable rotary member **50** and the wire spring **84** altogether. Formed in this gear cover **85** are an opening **86** which enables the coupling portion **54** of the input gear **45** to be exposed and an opening **87** which enables the raised portion **70**, the cylindrical portion **71**, the first detectable portion **72**, the second detectable portion **73** and the third detectable portion **74** of the detectable rotary member **50** to be exposed.

3. Interference Member

As shown in FIG. **3**A, the interference member **91** is provided in the body casing **2** in a position which opposes the first side wall **41** of the developing cartridge **7** in the left-right direction and opposes the second detectable portion **73** in an up-down direction. The interference member **91** includes a support portion **92** and an operating portion **93**. The support portion **92** has a plate shape, is thick in the up-down direction and extends in the front-rear direction. The operating portion **93** has a plate shape, extends obliquely upwards and rearwards from an intermediate portion in the front-rear direction on an upper surface of the support portion **92** and is bent to extend further to the rear with a space defined between the support portion **92** and itself.

4. Detection Mechanism

As shown in FIGS. **3**A to **3**C, a detection mechanism is provided in the body casing **2** for detecting the first detectable portion **72**, the second detectable portion **73** and the third detectable portion **74**. This detection mechanism includes an actuator **94** and a light sensor **95** (an example of a detection member).

The actuator **94** integrally includes a swing shaft **96** which extends in the left-right direction, an abutment lever **97** which extends downwards from a right end portion of the swing shaft **96** and an optical path interruption lever **98** which extends upwards from a portion of the swing shaft **96** which is spaced away to the left from the portion where the abutment lever **97** is connected. The swing shaft **96** is held rotatably on an inner wall portion (not shown) of the body casing **2**. The abutment lever **97** and the optical path interruption lever **98** intersect each other at an angle of about 130°.

The actuator **94** can swing to a detecting posture in which the abutment lever **97** extends substantially perpendicularly downwards from the swing shaft **96** and the optical path interruption lever **98** extends forwards and upwards from the swing shaft **96** as shown in FIG. **3**C and a non-detecting posture in which the optical path interruption lever **98** extends substantially perpendicularly upwards from the swing shaft **96** and the abutment lever **97** extends forwards and downwards from the swing shaft **96**. The actuator **94** is designed to take the non-detecting posture by a spring force of a spring (not shown) in such a state that no other external force than the spring force is exerted thereon.

The light sensor **95** includes a light emitting element and a light receiving element which are provided to oppose each other in the left-right direction. The light sensor **95** is provided in a position where an optical path extending from the light emitting element to the light receiving element is interrupted by the optical path interruption lever **98** of the actuator **94** which is taking the detecting posture. The light sensor **95** continues to output an ON signal while the optical path extending from the light emitting element to the light receiving element is being interrupted by the optical path interruption lever **98** and continues to output an OFF signal while the optical path is not interrupted (light from the light emitting element reaches the light receiving element).

5. Detection of Mounting of Developing Cartridge and Detection of Whether Developing Cartridge is New or Used

As shown in FIGS. **2**A to **2**C, with a new developing cartridge **7**, the second detectable portion **73** extends perpendicularly downwards from the cylindrical portion **71**. In addition, as shown in FIG. **2**D, with a new developing cartridge **7**, the engagement portion **78** is provided in the position situated outside the rotating locus drawn by the engagement portion **66** when the agitator gear **49** rotates. Specifically, the engagement portion **78** is situated in such a position as to oppose an upper end portion of the small-diameter gear portion **65** of the agitator gear **49** in the front-rear direction when viewed from a side thereof.

A rotating position of the detectable rotary member **50** when the engagement portion **78** is provided in the above position corresponds to an example of a retreat position.

The developing cartridge **7** is mounted in the body casing **2** with the front cover **4** open. When a new developing cartridge **7** is mounted in the body casing **2**, in the midst of mounting thereof, as shown in FIGS. **3**A to **3**C, the distal end portion **73**A of the second detectable portion **73** is brought into abutment with an upper surface of a sloping portion of the operating portion **93** of the interference member **91**. By a rearward movement of the developing cartridge **7** as a result of mounting thereof into the body casing **2**, the distal end portion **73**A of the second detectable portion **73** slides on an upper surface of the sloping portion of the operating portion **93** in a rubbing manner and is lifted upwards in accordance with the inclination of the sloping surface. By the distal end portion **73**A being lifted upwards, the detectable rotary member **50** rotates clockwise when viewed in FIGS. **3**B to **3**D through about 10° (T1 to T2 in FIG. **12**), whereby the engagement portion **78** is provided on the rotating locus of the engagement portion **66** as shown in FIG. **3**D.

When the mounting of the developing cartridge **7** is completed, as shown in FIGS. **3**A to **3**C, a distal end portion of the first detectable portion **72** is brought into abutment with a lower end portion of the abutment lever **97** of the actuator **94**, whereby the lower end portion is pressed to the rear, causing the actuator **94** to take the detecting posture. As a result, the optical path extending from the light emitting element to the light receiving element is interrupted by the optical path interruption lever **98**, whereby an ON signal is outputted from the light sensor **95** (T1 in FIG. **12**). In this way, an indirect detection of the first detectable portion by the light sensor **95** is performed.

The rotational position of the detectable rotary member **50** corresponds to an example of an initial position where the first detectable portion **72** is detected by the light sensor **95**.

When the mounting of the developing cartridge **7** is completed and the front cover **4** is closed, a warming-up operation of the laser printer **1** is started. In this warming-up operation, the driving force output member (refer to FIG. **2**A) is inserted in the coupling recess portion **55** of the input gear **45** so that a driving force is inputted into the input gear **45** from the driving force output member **56**, whereby the input gear **45** rotates. Then, the developing gear **46**, the supply gear **47** and the intermediate gear **48** rotate in association with the rotation of the input gear **45**, whereby the developing roller **18** and the supply roller **19** rotates. The agitator gear **49** rotates (T3 in FIG. **12**) in association with the rotation of the intermediate gear **48**, whereby the agitator **16** (refer to FIG. **1**) rotates. Toner in the developing cartridge **7** is loosened by the rotation of the agitator **16**.

As FIGS. **4**C, **5**C and **6**C show sequential rotational positions of the agitator gear **49**, the agitator gear **49** rotates clockwise in FIGS. **4**C, **5**C, **6**C. As the agitator gear **49** rotates, the engagement portion **66** is not in contact with the engagement portion **78**, and the gear teeth **76** of the partly non-tooth gear portion **69** of the agitator gear **49** do not mesh with the gear teeth **67** of the agitator gear **49**. Therefore, as shown in FIGS. **4**A to **4**D, **5**A to **5**D and **6**A to **6**D, the detectable rotary member **50** does not rotate, and the rotational position of the detectable rotary member **50** does not change.

Then, when the rotation of the agitator gear **49** progresses, as shown in FIGS. **7**A, **7**C, **7**D, the engagement portion **66** comes into abutment with the engagement portion **78**. Specifically, as shown in FIG. **7**E, the engagement portion **66** comes into abutment with the engagement portion from the above.

Then, when the rotation of the agitator **49** progresses further, as shown in FIGS. **8**A, **8**C, **8**D, the engagement portion **78** is pressed against by the engagement portion **66**, and the detectable rotary member **50** rotates counterclockwise in FIGS. **8**A, **8**C, **8**D (T4 in FIG. **12**), whereby the gear teeth **76** of the partly non-tooth gear portion **69** of the detectable rotary member **50** mesh with the gear teeth **67** of the agitator gear **49**.

Thereafter, the gear teeth **76** moves by following the rotation of the agitator gear **49**, whereby the detectable rotary member **50** rotates. As a result of the rotation of the detectable rotary member **50**, as shown in FIGS. **9**A to **9**C, the distal end portion of the first detectable portion **72** moves away from the abutment lever **97**, and the actuator **94** changes its posture from the detecting posture to the non-detecting posture. As a result, the optical path interruption lever **98** moves out of the optical path which extends from the light emitting element to the light receiving element of the light sensor **95**, whereby an OFF signal is outputted from the light sensor **95** (T5 in FIG. **12**).

Thereafter, when the rotation of the agitator gear **49** and the detectable rotary member **50** progresses, as shown in FIGS. **10**A to **10**C, a distal end portion of the third detectable portion **74** comes into abutment with the lower end portion of the abutment lever **97**, whereby the lower end portion is pressed to the rear, causing the actuator **94** to change its posture again from the non-detecting posture to the detecting posture. As a result, the optical path extending from the light emitting element to the light receiving element of the light sensor **95** is interrupted by the optical path interruption lever **98**, whereby an ON signal is outputted from the light sensor **95** (T6 in FIG. **12**). This attains an indirect detection of the third detectable portion **74** by the light sensor **95**.

Then, when the rotation of the agitator gear **49** and the detectable rotary member **50** progresses further, the distal end portion of the third detectable portion **74** moves away from the abutment lever **97** of the actuator **94**, whereby the actuator **94** changes its posture again from the detecting posture to the non-detecting posture. As a result, the optical path interruption lever moves out of the optical path extending from the light emitting element to the light receiving element of the light sensor **95**, whereby an OFF signal is outputted from the light sensor **95** (T7 in FIG. **12**).

Thereafter, when the rotation of the agitator gear **49** and the detectable rotary member **50** progresses further, as shown in FIGS. **11**A to **11**C, the distal end portion **73**A of the second detectable portion **73** comes into abutment with the lower end portion of the abutment lever **97**, whereby the lower end portion is pressed to the rear, causing the actuator **94** to change its posture again from the non-detecting posture to the detecting posture. As a result, the optical path extending from the light emitting element to the light receiving element of the light sensor **95** is interrupted by the optical path interruption lever **98**, whereby an ON signal is outputted from the light sensor **95** (T8 in FIG. **12**). This attains an indirect detection of the second detectable portion **73** by the light sensor **95**.

Then, as shown in FIG. **11**D, when the rotation of the agitator gear **49** and the detectable rotary member **50** progresses further and the meshing engagement of the gear teeth **76** of the detectable rotary member **50** with the gear teeth **67** of the agitator gear **49** is released, the detectable rotary member stop rotating (T9 in FIG. **12**). Thereafter, by the pressed portion **79** of the detectable rotary member **50** being pressed to the rear by the wire spring **84**, the rotational position of the detectable rotary member **50** is held in the rotational position thereof when the meshing engagement of the gear teeth **76** of the detectable rotary member **50** with the gear teeth **67** of the agitator gear **49** is released, whereby the detectable rotary member **50** does not rotate in any way.

When a predetermined length of time elapses after the front cover **4** is closed, the warming-up operation ends, and the motor (not shown) stops rotating the driving force output member **56**, whereby the input of the driving force from the driving force output member **56** into the input gear **45** is stopped.

In this way, when the new developing cartridge **7** is mounted into the body casing **2** for the first time, there occurs twice the situation in which the OFF signal is outputted from the light sensor **95**. Consequently, when there occurs twice the situation in which the OFF signal is outputted from the light sensor **95** after the developing cartridge **7** is mounted into the body casing **2**, it can be determined that the developing cartridge **7** mounted is new.

Further, if the developing cartridge **7** is new, when the developing cartridge **7** is mounted into the body casing **2**, the distal end portion of the first detectable portion **72** presses the lower end portion of the abutment lever **97** of the actuator **94** to the rear, whereby the actuator **94** takes the detecting posture, and the ON signal is outputted from the light sensor **95**. In addition, even if the developing cartridge **7** is not new or used, when the developing cartridge **7** is mounted into the body casing **2**, the distal end portion **73**A of the second detectable portion **73** presses the lower end portion of the abutment lever **97** of the actuator **94** to the rear, whereby the actuator **94** takes the detecting posture, and the ON signal is outputted from the light sensor **95**. Consequently, irrespective of the developing cartridge **7** being new or used, the ON signal is outputted from the light sensor **95** in such a state that the developing cartridge **7** is mounted in the body casing **2**. Therefore, whether or not the developing cartridge **7** is mounted in the body casing **2** can be determined based on whether or not the ON signal is outputted from the light sensor **95**.

It is noted that the third detectable portion **74** may be omitted. If the third detectable portion **74** is omitted, when the developing cartridge **7** is mounted into the body casing **2**, as shown in FIG. **13**, no ON signal is outputted from the light sensor **95** during a time T6 to T7, and there occurs only once the situation in which the OFF signal is outputted from the light sensor **95**. Consequently, it can be determined from the fact that the situation occurs once in which the OFF signal is outputted from the light sensor **95** that the developing cartridge **7** mounted is new

For example, the developing cartridge **7** on which the third detectable portion **74** is provided accommodates a relatively large amount of toner in the housing **13** thereof, while the developing cartridge **7** from which the third detectable portion **74** is omitted accommodates a relatively small amount of toner in the housing **13** thereof. When these developing cartridges **7** are mounted into the body casing **2** selectively, the type of the developing cartridge **7** mounted can be determined by the number of times of occurrence of the situation in which the OFF signal is outputted from the light sensor **95** after the new developing cartridge **7** is mounted in the body casing **2**.

These determinations of whether or not the developing cartridge **7** is mounted in the body casing **2** and whether the developing cartridge **7** mounted is new or used are executed by a control unit (not shown) that a microcomputer has. Specifically, the control unit executes, for example, operations shown in a flowchart in FIG. **18** to determine whether or not the developing cartridge **7** is mounted in the body casing **2** and whether the developing cartridge **7** mounted is new or used.

The flowchart shown in FIG. **18** is executed in response to the closure of the front cover **4**.

When the front cover **4** is closed, firstly, it is checked whether or not the output signal from the light sensor **95** is the ON signal (ON) (S**1**).

If the output signal from the light sensor **95** is the ON signal (S**1**: YES), the warming-up operation is started, and the driving of the motor is started to rotate the driving force output member **56** in such a state that the driving force output member **56** is coupled to the coupling recess portion **55** of the input gear **45** (S**2**).

While the motor is being driven, the state of the output signal from the light sensor **95** is monitored at all times (S**3**). Namely, output signals from the light sensor **95** are sampled at a predetermined cycle by the control unit, and whether the output signal from the light sensor **95** is the ON signal or the OFF signal is checked repeatedly. When the output signal from the light sensor **95** is switched from the ON signal to the OFF signal, every time the switching occurs, the value of a counter within the control unit is increased (by one). The value of the counter is reset to zero when this operation starts.

When a predetermined length of time elapses from the start of driving of the motor (S**4**: YES), the driving of the motor is stopped, and the warming-up operation ends.

Then, it is checked whether or not the OFF signal is outputted from the light sensor **95** during the period of time when the motor is driven (the monitoring period) (S**5**). Specifically, it is checked whether the value of the counter is 1 or 2, or zero.

If the value of the counter is 1 or 2, it is determined that the developing cartridge **7** mounted is new (S**6**). In an example which is in greater detail, if the value of the counter is 1, it is determined that the developing cartridge **7** mounted is new and accommodates the relatively small amount of toner, while if the value of the counter is 2, it is determined that the developing cartridge **7** mounted is new and accommodates the relatively large amount of toner.

On the other hand, if the value of the counter is zero, it is determined that the developing cartridge **7** mounted is used (S**7**).

In addition, if the output signal from the light sensor **95** immediately after the front cover **4** is closed is the OFF signal (S**1**: NO), it is determined that no developing cartridge **7** is mounted in the body casing **2** (S**8**).

6. Functions and Advantages

(1) Function and Advantage 1

As described above, the input gear **45** and the detectable rotary member **50** are provided on the outer side of the first side wall **41** of the housing **13** to be rotatable, respectively, about the axes of the input gear rotation shaft **51** and the rotation shaft **68** which extend in parallel to each other. The axes of the input gear rotation shaft **51** and the rotation shaft **68** are examples of a first axis and a third axis, respectively. The developing roller **18** is provided to be rotatable about the developing rotation axis **20** between the first side wall **41** and the second side wall **42**.

The driving force output member **56** provided in the body casing **2** is coupled to the input gear **45**, whereby the driving force is inputted from the driving force output member **56** into the input gear **45**. The developing roller **18** is rotated by the driving force inputted into the input gear **45** (the driving force which the input gear **45** receives from the driving force output member **56**).

The detectable rotary member **50** has the first detectable portion **72** and the second detectable portion **73**. The second detectable portion **73** contacts the interference member **91** fixed in the body casing **2** in the process of mounting the developing cartridge **7** into the body casing **2**. Accordingly, the detectable rotary member **50** rotates from the retreat position which is the rotational position shown in FIGS. **2**A to **2**D to the initial position which is the rotational position shown in FIGS. **3**A to **3**D. As a result, the detectable rotary member **50** is put in a state in which the detectable rotary member **50** can be rotated by the driving force from the input gear **45** (a state in which the engagement portion **66** can be brought into abutment with the engagement portion **78**).

Before the developing cartridge **7** is mounted in the body casing **2**, the rotational position of the detectable rotary member **50** is in the retreat position. In this position, the drive from the input gear **45** is cut off, and the detectable rotary member **50** cannot be rotated by the driving force that the input gear **45** receives.

In the production line of developing cartridges **7**, there may be a situation in which the operation of a developing cartridge **71** is checked after the assemblage thereof. For check of the operation of the developing cartridge **7**, the driving force is inputted into the input gear **45**, whereby the detectable rotary member **50** rotates. When the detectable rotary member **50** so rotates, the rotational position of the detectable rotary member **50** is offset from a proper position. Therefore, there may be caused a fear that information regarding the developing cartridge **7** is obtained erroneously. For example, in check of the operation of the developing cartridge **7**, when the detectable rotary member **50** rotates to a rotational position which is beyond the rotational position shown in FIGS. **11**B, **11**C, even a determination on whether the developing cartridge **7** mounted is new or used cannot be made. Namely, even with a new developing cartridge **7**, when the developing cartridge **7** is mounted in the body casing **2**, no OFF signal is outputted from the light sensor **95** even once, and hence, there may be caused a fear that it is determined that the developing cartridge **7** mounted is used.

When the rotational position of the detectable rotary member **50** is in the retreat position, even if the driving force is inputted into the input gear **45**, the detectable rotary member **50** does not rotate. Therefore, after the assemblage of a developing cartridge **7**, the operation of the developing cartridge **7** can be checked without rotating the detectable rotary member **50**. Consequently, there occurs no such situation in which the detectable rotary member **50** rotates to the rotational position which is not intended even when the operation of the developing cartridge **7** is checked. Because of this, even after the check of operation of the developing cartridge **7**, the first detectable portion **72**, the second detectable portion **73** and the third detectable portion **74** of the detectable rotary member **50** are held in the proper positions. Because of this, the first detectable portion **72** can be detected by the light sensor **95** after the developing cartridge **7** is mounted in the body casing **2**, based on which information regarding the developing cartridge **7** (information regarding whether or not the developing cartridge **7** is mounted) can be obtained well.

Consequently, although the developing cartridge **7** includes the detectable rotary member **50**, the developing cartridge **7** is more convenient than the conventional developing cartridge.

In addition, the first detectable portion **72** and the second detectable portion **73** are formed separately. Therefore, compared with a configuration in which they are formed as an integrated portion, the developing cartridge **7** is superior in wear resistance of the first detectable portion **72** and position accuracy of the first detectable portion **72** and the second detectable portion **73**.

Namely, when the first detectable portion **72** also functions as the second detectable portion **73**, there may be caused a fear that the first detectable portion **72** wears through contact with the interference member **91** in the body casing **2**. When the first detectable portion **72** wears, the abutment condition between the first detectable portion **72** and the abutment lever **97** of the actuator **94** becomes unstable, and there may be caused a fear that the accuracy with which the first detectable portion **72** is detected by the light sensor **95** is reduced. In case the first detectable portion **72** and the second detectable portion **73** are formed separately, the wear of the first detectable portion **72** due to the contact with the interference member **91** is eliminated, whereby a good detection of the first detectable portion **72** by the light sensor **95** can be performed.

In addition, in order for the function of each of the first detectable portion **72** and the second detectable portion **73** to be exhibited satisfactorily, the disposition of each of these portions is determined individually, and the first detectable portion **72** and the second detectable portion **73** can be provided in the positions determined with good accuracy. As a result, a good detection of the first detectable portion **72** by the light sensor **95** and a good contact of the second detectable portion **73** with the interference member **91** can be performed.

(2) Function and Advantage 2

The agitator gear **49** is provided on the outer side of the first side wall **41** to be rotatable about the axis of the agitator rotation shaft **62** which constitutes an example of a fourth axis, a fifth axis and a sixth axis. The agitator gear **49** is rotated by the driving force that the input gear **45** receives. The engagement portion **66** is formed on the agitator gear **49**.

On the other hand, the detectable rotary member **50** has the engagement portion **78**. The engagement portion **78** is provided so that the rotating locus drawn when the detectable rotary member **50** rotates partly overlaps the rotating locus drawn by the engagement portion **66**.

When the rotational position of the detectable rotary member **50** is in the retreat position, the engagement portion **78** is provided outside the rotating locus of the engagement portion **66**. Consequently, even though the agitator gear **49** (the engagement portion **66**) rotates in this state, the engagement portion **66** is not brought into engagement with the engagement portion **78**. Then, when the detectable rotary member **50** rotates from the retreat position to the initial position, the engagement portion **78** is provided on the rotating locus of the engagement portion **66**. When the agitator gear **49** rotates in this state, the engagement portion **66** is brought into engagement with the engagement portion **78**. When the agitator gear **49** rotates in this state, the engagement portion **66** is brought into engagement with the engagement portion **78**, whereby a force is exerted on the engagement portion **78** from the engagement portion **66**, and the detectable rotary member **50** rotates.

Consequently, by the simple configuration having the engagement portion **66** and the engagement portion **78**, when the rotational position of the detectable rotary member **50** is in the retreat position, the detectable rotary member **50** can be surely prevented from being rotated by the driving force that the input gear **45** receives. In addition, when the detectable rotary member **50** is rotated from the retreat position to the initial position, the detectable rotary member **50** can be rotated by the driving force that the input gear **45** receives.

(3) Function and Advantage 3

The gear teeth **67** are formed on the circumferential surface of the small-diameter gear portion **65** of the agitator gear **49**.

On the other hand, the non-tooth portion **77** is formed on a part of the circumferential surface of the partly non-tooth gear portion **69** of the detectable rotary member **50**, and the gear teeth **76** are formed on a part of the circumferential surface other than the non-tooth portion **77** to mesh with the gear teeth **67**.

Then, when the rotational position of the detectable rotary member **50** is in the retreat position and the initial position, the non-tooth portion **77** of the detectable rotary member **50** comes to oppose the gear teeth **67** of the agitator gear **49**. Because of this, when the rotational position of the detectable rotary member **50** is in the retreat position and the initial position, even if the agitator gear **49** is rotated by the driving force received by the input gear **45**, the gear teeth **76** of the detectable rotary member **50** do not come to mesh with the gear teeth **67** of the agitator gear **49** immediately. Consequently, the detectable rotary member **50** can be prevented from rotating immediately by following the rotation of the agitator gear **49**, when the rotational position of the detectable rotary member **50** is in the retreat position and the initial position.

(4) Function and Advantage 4

The developing cartridge **7** includes the agitator **16**. Therefore, toner accommodated in the housing **13** can be agitated by the rotating agitator **16**.

With a new developing cartridge **7**, there may be a situation in which toner in the housing **13** solidifies. In this case, a large load (resistance) is exerted on the agitator **16** which integrally rotates with the agitator gear **49** immediately after the new developing cartridge **7** is mounted in the body casing **2** and the agitator gear **49** starts rotating by the driving force that the input gear **45** receives from the driving force output member **56**. Then, when the toner is started to be loosened, the load exerted on the agitator **16** is reduced, and the magnitude of the load is stabilized at a substantially constant level. Consequently, the rotation of the agitator gear **40** becomes unstable from the start of rotation of the agitator gear **49** until the loosening of the solidified toner.

The detectable rotary member **50** does not follow the rotation of the agitator gear **49** immediately after the driving force output member **56** is started to be driven (immediately after the driving force is started to be inputted into the input gear **45**). The detectable rotary member **50** starts to follow the rotation of the agitator gear **49** after the passage of the time required from the start of driving of the driving force output member **56** until the engagement of the engagement portion **66** with the engagement portion **78**. Consequently, the detectable rotary member **50** is allowed to follow the rotation of the agitator gear **49** after the toner solidified in the housing **13** is loosened. As a result, the rotation of the detectable rotary member **50** can be stabilized further, thereby making it possible to allow the first detectable portion **72** to move at the stable speed.

In addition, even when toner in the housing **13** does not solidify, the magnitude of the driving force inputted into the input gear **45** from the driving force output member **56** is still unstable immediately after the driving force output member **56** is started to be driven. Consequently, by the detectable rotary member **50** starting to rotate after the passage of the time required from the start of driving of the driving force output member **56** until the engagement of the engagement portion **66** with the engagement portion **78**, the detectable rotary member **50** is allowed to be rotated by the driving force whose magnitude becomes stable, whereby the first detectable portion **72** is allowed to move at stabler speeds.

(5) Function and Advantage 5

The first detectable portion **72** and the second detectable portion **73** extend in the radius direction of a rotation of the detectable rotary member **50**. The second detectable portion **73** projects outside the rotating locus drawn by the first detectable portion **72** when the detectable rotary member **50** rotates, and the projecting distal end portion **73**A of the second detectable portion **73** constitutes an abutment portion with which the interference member **91** is brought into abutment when the developing cartridge **7** is mounted into the body casing **2**. By this configuration, while the interference member **91** is allowed to be surely brought into abutment with the second detectable portion **73**, the first detectable portion **72** can be prevented from being brought into abutment with the interference member **91** when the detectable rotary member **50** rotates.

(6) Function and Advantage 6

In addition, since the first detectable portion **72** and the second detectable portion **73** are provided away from each other in the rotating direction of the detectable rotary member **50**, even though the detectable rotary member **50** does not rotate through 360°, the rotational position of the detectable rotary member **50** is changed from the initial position where the first detectable portion **72** is detected by the light sensor **95** to the position where the second detectable portion **73** is detected by the light sensor **95**. Because of this, due to the detectable rotary member **50** including the first detectable portion **72** and the second detectable portion **73**, the detection of the first detectable portion **72** and the second detectable portion **73** by the light sensor **95** can be performed without rotating the detectable rotary member **50** through 360°, while due to the detectable rotary member **50** including the partly non-tooth gear portion **69**, the transmission of the driving force from the agitator gear **49** to the detectable rotary member **50** can be cut off when the detectable rotary member **50** rotates to the position where the second detectable portion **73** is detected by the light sensor **95**.

For example, it might be considered that both the determination of whether or not the developing cartridge **7** mounted is new and the determination of whether or not the developing cartridge **7** is mounted in the body casing **2** can be implemented by detecting only the first detectable portion **72** by the light sensor **95** with the second detectable portion **73** omitted.

In this case, it is necessary that the first detectable portion **72** comes into abutment with the abutment lever **97** of the actuator **94** so that the first detectable portion **72** is detected by the light sensor **95** at a point in time when the new developing cartridge **7** is mounted in the body casing **2**. Then, it is necessary that after the first detectable portion **72** temporarily moves away from the abutment lever **97** by the rotation of the detectable rotary member **50**, the detectable rotary member **50** rotates through 360° after the installation of the developing cartridge **7**, causing the first detectable portion **72** to come into abutment with the abutment lever **97** again so that the first detectable portion **72** is detected by the light sensor **95**. Further, the transmission of the driving force from the agitator gear **49** to the detectable rotary member **50** has to be cut off at a point in time when the detectable rotary member **50** rotates through 360°.

These three requirements cannot be satisfied by the configuration in which the partly non-tooth gear portion **69** is provided. To satisfy those requirements, a complex mechanism such as a clutch mechanism has to be provided, which makes the configuration of the developing cartridge **7** (the laser printer **1**) complex and increases the manufacturing costs thereof.

By including the second detectable portion **73** separately from the first detectable portion **72** and including the partly non-tooth gear portion **69**, the three requirements can be satisfied which are necessary to determine well whether or not the developing cartridge **7** mounted new or used and whether or not the developing cartridge **7** is mounted in the body casing **2**.

7. Modified Examples

(1) Modified Example 1

In the laser printer **1**, the engagement portion **66** is formed integrally on the small-diameter gear portion **65** of the agitator gear **49**. As shown in FIG. **14**, however, for example, a cylindrical connecting member **141** may be provided as a separate member from a small-diameter gear portion **65**. In this case, an engagement portion **66** is formed on the connecting member **141** so as to project from a circumferential surface of the connecting member **141**, and the connecting member **141** is connected to the small-diameter gear portion **65** to rotate together therewith (so as not to rotate relatively).

In this case, the small-diameter gear portion **65** and the connecting member **141** can rotate together by fitting two bosses **142** provided on the connecting member **141** so as to extend towards the small-diameter gear portion **65** in recess portions **143** provided in the small-diameter gear portion **65**.

(2) Modified Example 2

In addition, as shown in FIG. **15**, an engagement portion **66** may be formed on a different gear **151** to which a driving force is transmitted from an intermediate gear **48** so as to project from a circumferential surface of the gear **151** at a distal end thereof, so that an engagement portion **78** is pressed by the gear **151** when it rotates. In this case, a detectable rotary member **50** rotates to a position where a partly non-tooth gear portion **69** receives a drive force from a small-diameter gear portion **65** of an agitator gear **49** by firstly the engagement portion **78** being brought into contact with the engagement portion **66** provided on the gear **151**.

(3) Modified Example 3

A first detectable portion **72** and a second detectable portion **73** may be integrated together. For example, as shown in FIG. **16**, connecting portions **161**, **162**, which extend along an outer circumferential surface of a cylindrical portion **71** and constitute an example of a non-detecting portion, are formed between the first detectable portion **72** and a third detectable portion **74** and between the third detectable portion **74** and the second detectable portion **73**, respectively, so that the first detectable portion **72**, the second detectable portion **73** and the third detectable portion **74** are integrated together.

In this case, a configuration may be adopted in which an abutment lever **97** of an actuator **94** is brought into abutment with connecting portions **161**, **162**. In this configuration, a height of the connecting portions **161**, **162** (a length of a detectable rotary member **50** in the direction of turning radius) is formed smaller than lengths of the first detectable portion **72** and the second detectable portion **73** and is formed to such an extent that even though an abutment lever **97** of an actuator **94** is brought into abutment with the connecting portions **161**, **162**, an optical path interruption lever **98** of the actuator **94** is prevented from moving out of an optical path of the light sensor **95**.

(4) Modified Example 4

In the laser printer **1**, the partly non-tooth gear portion **69** is provided on the detectable rotary member **50**, and the gear teeth **76** are formed on the outermost circumferential surface of the partly non-tooth gear portion **69**. However, the following configuration may be adopted in place of the cylindrical portion on an outer side of the partly non-tooth gear portion **69**. For example, as shown in FIG. **17**, a fan-shaped main body **171** which is centered at a rotation shaft **68** of a detectable rotary member **50** and a resistance imparting member **173** may be provided. At least an outer circumferential surface of the resistance imparting member **173** is formed of a material such as a rubber having a relatively large friction coefficient, and the resistance imparting member **173** is wound round an outer circumference of a wall portion **172** erected along a circumferential edge of the main body **171**. In this case, gear teeth **67** may be formed or may not be formed on a circumferential surface of a small-diameter gear portion **65** of an agitator gear **49**. The main body **171** and the resistance imparting member **173** are sized so that an angle formed by two planes of the outer circumferential surface of the resistance imparting member **173** is about 230° and that those plane do not contact the small-diameter gear portion **65** but an arc surface of the outer circumferential surface of the resistance imparting member **173** contacts the circumferential surface of the small-diameter gear portion **65**.

(5) Modified Example 5

To determine whether or not the developing cartridge **7** is mounted in the body casing **2** and whether the developing cartridge **7** mounted is new or used, the control unit executes operations shown in a flowchart in FIG. **19** in place of the operations shown in the flowchart in FIG. **18**.

The flowchart in FIG. **19** is executed in response to the closure of the front cover **4**.

When the front cover **4** is closed, a warming-up operation is started, and the motor (not shown) is started to be driven to rotate the driving force output member **56** in such a state that the driving force output member **56** is coupled to the coupling recess portion **55** of the input gear **45** (S**11**).

While the motor is being driven, the state of an output signal from the light sensor **95** is monitored at all times (S**12**). Namely, output signals of the light sensor **95** are sampled at a predetermined cycle by the control unit so as to check repeatedly whether the output signal from the light sensor **95** is an ON signal or an OFF signal. When the output signal from the light sensor **95** is switched from the ON signal to the OFF signal, every time the output signal is so switched, the value of the counter in the control unit is increased (by one). The value of the counter is reset to zero when this operation is started.

The driving of the motor is stopped after the passage of a predetermined length of time from the start of driving of the motor (S**13**: YES), and the warming-up operation ends.

Thereafter, it is checked whether or not the output signal from the light sensor **95** is the ON signal (ON) (S**14**).

If the output signal from the light sensor **95** is the ON signal (S**14**: YES), it is checked whether or not the OFF signal is outputted from the light sensor **95** during a period of time when the motor is driven (a monitoring period) (S**15**). Specifically, it is checked whether the value of the counter in the control unit is 1 or 2.

If the value of the counter is 1 or 2, it is determined that the developing cartridge **7** mounted is new (S**16**). In an example which is greater detail, if the value of the counter is 1, it is determined that the developing cartridge **7** is new and accommodates a relatively small amount of toner. If the value of the counter is 2, it is determined that the developing cartridge **7** is new and accommodates a relatively large amount of toner.

On the other hand, if the value of the counter is zero, it is determined that the developing cartridge **7** is used (S**17**).

In addition, if the output signal from the light sensor **95** at a point in time when the warming-up operation ends is the OFF signal (S**14**: NO), it is determined that no developing cartridge **7** is mounted in the body casing **2** (S**18**).

While the present invention has been shown and described with reference to certain exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A developing cartridge comprising:

a housing configured to accommodate developer therein;

a first rotary member provided outside of the housing and including radial protrusions, the first rotary member being rotatable about a first axis, wherein at least one radial protrusion of the first rotary member extends farther in an axial direction of the first axis than at least one other radial protrusion of the first rotary member; and

a second rotary member provided outside of the housing, the second rotary member configured to be rotatable about a second axis different from the first axis, the second rotary member including radial protrusions, wherein at least one radial protrusion of the second rotary member extends less than at least one other radial protrusion of the second rotary member in the axial direction of the second axis.

2. The developing cartridge of claim **1**, wherein the first rotary member and the second rotary member are provided on an exterior surface of the housing.

3. The developing cartridge of claim **1**, wherein, in a state in which the first rotary member rotates with the second rotary member, the at least one radial protrusion of the first rotary member contacts the at least one radial protrusion of the second rotary member.

4. The developing cartridge of claim **1**, wherein the radial protrusions of the second rotary member comprise at least one gear tooth.

5. The developing cartridge of claim **4**, wherein the second rotary member includes a first portion and a second portion along a circumference of the second rotary member, wherein the second portion is toothless.

6. The developing cartridge of claim **5**, wherein the at least one radial protrusion of the second rotary member defines a boundary of the second portion in a direction opposite to a rotational direction of the second rotary member.

7. The developing cartridge of claim **1**, wherein the second rotary member is configured to rotate from a first position to a second position, wherein, in the second position, the second rotary member is positioned with the at least one radial protrusion of the second rotary member within a rotational circumference defined by the at least one radial protrusion of the first rotary member.

8. The developing cartridge of claim **7**, wherein the second rotary member is configured to rotate with the first rotary member in a case where the second rotary member has rotated to the second position.

9. The developing cartridge of claim **1**, wherein the second rotary member further includes a detection member extending in at least the axial direction of the second axis, and

wherein the detection member is configured to receive a rotational pressing force from a portion of an image forming apparatus upon the developing cartridge being mounted to the image forming apparatus.

10. The developing cartridge of claim **1**, wherein the first rotary member includes an agitator gear supported by a shaft and the shaft further supporting an agitator.

11. The developing cartridge of claim **1**, wherein the second rotary member includes a gear.

12. The developing cartridge of claim **1**, wherein the at least one radial protrusion of the second rotary member is disposed within a rotational circumference of the at least one radial protrusion of the first rotary member while all other radial protrusions of the second rotary member are disposed outside of the rotational circumference of the at least one radial protrusion of the first rotary member.

13. The developing cartridge of claim **12**, wherein the at least one radial protrusion of the second rotary member includes a first end and a second end in the axial direction of the second axis, the first end being closer to the first rotary member in the axial direction of the second axis than the second end,

wherein the radial protrusions of the first rotary member each include a respective first end and a respective second end in the axial direction of the first axis, the first end of the at least one radial protrusion of the second rotary member being disposed closer to the first ends of the radial protrusions of the first rotary member in the axial direction of the first axis than to the second ends of the radial protrusions of the first rotary member,

wherein, in the axial direction of the first axis:

a distance between the first end and the second end of the at least one radial protrusion of the first rotary member is greater than a distance between the second end of the at least one radial protrusion of the first rotary member and the first end of the at least one radial protrusion of the second rotary member, and

each distance between the respective first and second ends of all other radial protrusions of the first rotary member is less than the distance between the second end of the at least one radial protrusion of the first rotary member and the first end of the at least one radial protrusion of the second rotary member.

14. The developing cartridge of claim **1**, wherein the at least one radial protrusion of the second rotary member is disposed within a rotational circumference of the at least one radial protrusion of the first rotary member.

15. A developing cartridge for use in an image forming apparatus, the developing cartridge comprising:

a housing configured to accommodate developer therein;

a first rotary member provided outside of the housing and including radial protrusions, the first rotary member being rotatable about a first axis, wherein at least one radial protrusion of the first rotary member extends farther in an axial direction of the first axis than at least one other radial protrusion of the first rotary member; and a second rotary member provided outside of the housing, the second rotary member configured to be rotatable about a second axis different from the first axis, the second rotary member including radial protrusions, wherein at least one radial protrusion of the second rotary member extends less than at least one other radial protrusion of the second rotary member in the axial direction of the second axis.

16. The developing cartridge of claim **15**, wherein the first rotary member and the second rotary member are provided on an exterior surface of the housing.

17. The developing cartridge of claim **15**, wherein, in a state in which the first rotary member rotates with the second rotary member, the at least one radial protrusion of the first rotary member contacts the at least one radial protrusion of the second rotary member.

18. The developing cartridge of claim **15**, wherein the radial protrusions of the second rotary member comprise at least one gear tooth.

19. The developing cartridge of claim **18**, wherein the second rotary member includes a first portion and a second portion along a circumference of the second rotary member, wherein the second portion is toothless.

20. The developing cartridge of claim **19**, wherein the at least one radial protrusion of the second rotary member defines a boundary of the second portion in a direction opposite to a rotational direction of the second rotary member.

21. The developing cartridge of claim **15**, wherein the second rotary member is configured to rotate from a first position to a second position, wherein, in the second position, the second rotary member is positioned with the at least one radial protrusion of the second rotary member within a rotational circumference defined by the at least one radial protrusion of the first rotary member.

22. The developing cartridge of claim **21**, wherein the second rotary member is configured to rotate with the first rotary member in a case where the second rotary member has rotated to the second position.

23. The developing cartridge of claim **15**, wherein the second rotary member further includes a detection member extending in at least the axial direction of the second axis, and

wherein the detection member is configured to receive a rotational pressing force from a portion of an image forming apparatus upon the developing cartridge being mounted to the image forming apparatus.

24. The developing cartridge of claim **15**, wherein the first rotary member includes an agitator gear supported by a shaft and the shaft further supporting an agitator.

25. The developing cartridge of claim **15**, wherein the second rotary member includes a gear.

26. The developing cartridge of claim **15**, wherein the at least one radial protrusion of the second rotary member is disposed within a rotational circumference of the at least one radial protrusion of the first rotary member while all other radial protrusions of the second rotary member are disposed outside of the rotational circumference of the at least one radial protrusion of the first rotary member.

27. The developing cartridge of claim **26**, wherein the at least one radial protrusion of the second rotary member includes a first end and a second end in the axial direction of the second axis, the first end being closer to the first rotary member in the axial direction of the second axis than the second end,

wherein the radial protrusions of the first rotary member each include a respective first end and a respective second end in the axial direction of the first axis, the first end of the at least one radial protrusion of the second rotary member being disposed closer to the first ends of the radial protrusions of the first rotary member in the axial direction of the first axis than to the second ends of the radial protrusions of the first rotary member,

wherein, in the axial direction of the first axis:

a distance between the first end and the second end of the at least one radial protrusion of the first rotary member is greater than a distance between the second end of the at least one radial protrusion of the first rotary member and the first end of the at least one radial protrusion of the second rotary member, and

each distance between the respective first and second ends of all other radial protrusions of the first rotary member is less than the distance between the second end of the at least one radial protrusion of the first rotary member and the first end of the at least one radial protrusion of the second rotary member.

28. The developing cartridge of claim **15**, wherein the at least one radial protrusion of the second rotary member is disposed within a rotational circumference of the at least one radial protrusion of the first rotary member.

29. A developing cartridge for use in an image forming apparatus, the developing cartridge comprising:

a housing configured to accommodate developer therein;

a first rotary member provided outside of the housing and including radial protrusions, the first rotary member being rotatable about a first axis, wherein at least one radial protrusion of the first rotary member extends farther in an axial direction of the first axis than at least one other radial protrusion of the first rotary member, the first rotary member configured to be rotated by at least a portion of the image forming apparatus; and

a second rotary member provided outside of the housing, the second rotary member configured to be rotatable about a second axis different from the first axis, the second rotary member including radial protrusions, wherein at least one radial protrusion of the second rotary member extends less than at least one other radial protrusion of the second rotary member in the axial direction of the second axis, the first rotary member configured to rotate the second rotary member,

wherein the at least one radial protrusion of the first rotary member is configured to be rotated, by the at least a portion of the image forming apparatus, a predefined amount with the at least one radial protrusion of the first rotary member separated from the at least one radial protrusion of the second rotary member in a circumferential direction of the first rotary member.

30. The developing cartridge of claim **29**, wherein the at least one radial protrusion of the second rotary member is disposed within a rotational circumference of the at least one radial protrusion of the first rotary member.

31. The developing cartridge of claim **29**, wherein the first rotary member includes an agitator gear supported by a shaft and the shaft further supporting an agitator.

32. The developing cartridge of claim **29**, wherein the second rotary member includes a gear.

33. The developing cartridge of claim **29**, wherein the first rotary member and the second rotary member are provided on an exterior surface of the housing.

34. The developing cartridge of claim **29**, wherein, in a state in which the first rotary member rotates the second rotary member, the at least one radial protrusion of the first rotary member contacts the at least one radial protrusion of the second rotary member.

35. The developing cartridge of claim **29**, wherein the radial protrusions of the second rotary member include at least one gear tooth.

36. The developing cartridge of claim **35**, wherein the second rotary member includes a first portion and a second portion along a circumference of the second rotary member, wherein the second portion is toothless.

37. The developing cartridge of claim **36**, wherein the at least one radial protrusion of the second rotary member defines a boundary of the second portion in a direction opposite to a rotational direction of the second rotary member.

38. The developing cartridge of claim **29**,

wherein the second rotary member is configured to rotate from a first position to a second position, and

wherein, in the second position, the second rotary member is positioned with the at least one radial protrusion of the second rotary member within a rotational circumference defined by the at least one radial protrusion of the first rotary member.

39. The developing cartridge of claim **38**, wherein the first rotary member is configured to rotate with the second rotary member in a case where the second rotary member has rotated to the second position.

40. The developing cartridge of claim **29**, wherein the second rotary member further includes a detection member extending in at least the axial direction of the second axis, and

wherein the detection member is configured to receive a rotational pressing force from a portion of the image forming apparatus upon the developing cartridge being mounted to the image forming apparatus.

41. The developing cartridge of claim **29**, wherein the at least one radial protrusion of the second rotary member is disposed within a rotational circumference of the at least one radial protrusion of the first rotary member while all other radial protrusions of the second rotary member are disposed outside of the rotational circumference of the at least one radial protrusion of the first rotary member.

42. The developing cartridge of claim **41**, wherein the at least one radial protrusion of the second rotary member includes a first end and a second end in the axial direction of the second axis, the first end being closer to the first rotary member in the axial direction of the second axis than the second end,

wherein the radial protrusions of the first rotary member each include a respective first end and a respective second end in the axial direction of the first axis, the first end of the at least one radial protrusion of the second rotary member being disposed closer to the first ends of the radial protrusions of the first rotary member in the axial direction of the first axis than to the second ends of the radial protrusions of the first rotary member,

wherein, in the axial direction of the first axis:

a distance between the first end and the second end of the at least one radial protrusion of the first rotary member is greater than a distance between the second end of the at least one radial protrusion of the first rotary member and the first end of the at least one radial protrusion of the second rotary member, and

each distance between the respective first and second ends of all other radial protrusions of the first rotary member is less than the distance between the second end of the at least one radial protrusion of the first rotary member and the first end of the at least one radial protrusion of the second rotary member.

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